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File No. 049130-0001

October 15, 2012

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Thomas A. Benson
Trial Attorney
Environmental Enforcement Section
U.S. Department of Justice
P.O. Box 7611
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Re: Ashland Lakefront Site -- Sediment Remedy

Dear Messrs. Melodia and Benson:

On behalf of the Northern States Power Company of Wisconsin ("NSPW" or the "Company"), we are pleased that the Consent Decree for the Phase I Project Area has been executed by the United States, State of Wisconsin, and NSPW and that the parties were able to work cooperatively in reaching a settlement regarding the cleanup of the on-land portion of the Site. As you know and as used herein, the Phase I Project Area is defined as the area of the Site generally comprising Kreher Park, the Upper Bluff/Filled Ravine and the Copper Falls aquifer (together, the "Uplands" or "on-land portion of the Site"). When the parties agreed to segment the Site into two separate areas for purposes of settlement negotiations, we also agreed to pause negotiations on issues related to the sediment portion of the Site while we focused on the Phase I Project Area. Now that the Uplands Consent Decree has been executed, and is awaiting court approval, it is time for the parties to restart negotiations concerning the sediment cleanup. We appreciate the opportunity to further address issues related to sediment remediation at the Site now with the United States Environmental Protection Agency ("EPA") and the Wisconsin Department of Natural Resources ("WDNR") (collectively, the "Agencies").

## A. Prior Negotiations

As you know, the Record of Decision ("ROD") for the Site issued in September 2010 selects a wet-dry hybrid remedy for the sediments, while allowing for the potential of a remedy change (via an explanation of significant differences ("ESD")) to a wet dredge only approach, following the successful completion of a pilot study.

The Agencies are already aware that the Company has serious concerns regarding the safety and implementability of a dry dredge hybrid approach. In particular, the dry dredge creates a significant risk of "basal heave," a catastrophic failure of the bay floor that would threaten the safety of the workers performing the remedy and cause wide distribution of the contaminants in the bay sediments. The dry dredge is also based on unrealistic expectations regarding the ability of a modest sheet pile wall to hold back Lake Superior, among other potential failure mechanisms. A dry dredge would also cause significant community disruption and potentially expose the community to greater impacts from noise, air emissions, odors, and the long-term closure of Kreher Park. Notably, however, there are less expensive, less dangerous, and more effective alternatives to the selected dry dredge. As such, the dry dredge is inconsistent with the National Contingency Plan ("NCP") and would be an unsafe and inappropriate remedy for this Site.

During the Special Notice period, commencing in April of 2011, NSPW began working with both agencies to develop potential approaches that might be implemented to address the remediation of the sediments. Given the concerns identified above regarding the dry dredge, the parties put their efforts towards extensive negotiations on an Administrative Order on Consent for a wet dredge pilot project. However, progress stalled as the parties struggled to find common ground on performance standards verification.

Rather than letting this impasse delay Site cleanup, the parties agreed to pause those negotiations and pursue the Phase I Project Area Consent Decree mentioned above. This approach allowed the parties to address the significant environmental concerns associated with the Uplands portion of the site immediately while reserving negotiations on the sediment issues for a later day. We also agreed that when we resumed discussions about the sediments, we would discuss a possible cash-out approach to final settlement.

## B. NSPW's Evaluation of the Weston Report

When the ROD was issued, NSPW was made aware of a report for the first time prepared by EPA's consultant, Weston Solutions, Inc. ("Weston"), titled "Conceptual Geotechnical Assessment For Sediment Removal at the Ashland/Northern States Power Lakefront Site in Ashland, Wisconsin" ("Weston Report"). Although the report is dated November 20, 2009 (after the close of the public comment period for the Proposed Plan on August 17, 2009), it was not provided to NSPW until more than **a year later** in October 2010, *after the ROD was issued*. It appears that the remedy selection in the ROD was based, at least in some material part, on the analysis in the Weston Report. The Company has now had an opportunity to review the Weston Report and has asked three separate consultants (Anchor QEA LLC, Gradient and Burns & McDonnell) to independently review it. Each of these firms comprise nationally-regarded engineering and consulting experts with particular expertise in sediments, and their respective qualifications are set forth in detail in attachments 2-A, 2-B and 2-C. Following their independent review of the proposed remedy and Weston analysis, all three consultants concluded that the Weston analysis does not support implementation of a dry dredge at this site, and all three expressed serious concerns about the safety, environmental risks, and feasibility of a dry dredge.[1]

Although Weston's "preliminary and conceptual" analysis concludes that "near-shore, bay bottom sediments likely can be safely removed using dry excavation techniques, *assuming that conceptual planning, final design engineering and implementation of the construction work are all properly executed*," it provides no specific guidance for safe implementation. Further, even Weston acknowledges that the "structural stability of the sheet pile wall, excavation bottom blowout, and piping of bay bottom sandy sediments are *significant worker/equipment safety concerns and represent potential '**fatal flaw**' failure mechanisms*" unique to the near shore dry excavation remedy. Weston Report, at 2 (emphasis added).

After independently reviewing the available information regarding sediment conditions and analyses of the potential risks, the three consultants mentioned above have each separately confirmed the Company's concerns about the dry dredge remedy. These consultants, whose review has been more rigorous and thorough than Weston's self-described "preliminary and conceptual" analysis, each have concluded that a dry dredge is an inappropriate remedy for the Site and could result in catastrophic and irreparable harm to human health and the environment. They also have determined that the dry dredge cannot be performed consistent with nationally-recognized safety standards. NSPW's specific concerns with the Weston Report, and dry dredge remedy generally, are set forth in the attached briefing, and include without limitation:

- Risk of basal heave and other catastrophic remedy failures;
- Containment failure;
- Risk of NAPL migration;
- Increased risk of exposure to emissions, including benzene and naphthalene; and,
- Constructability and implementability issues.

If these risks were to materialize, it could result in <u>serious harm to workers, to the community, and to the environment</u> – harm that could be irreparable.

These risks, among others, are summarized in the attached fact sheets (Attachment 1) and Summary Report (Attachment 2), and are described in greater detail in the following attached consultant reports:

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[1] Three additional consultants, AECOM, URS Corporation and Foth Infrastructure & Environment LLC, also expressed serious concerns with the dry dredge, prior to the release of the Weston Report.

- *Independent Evaluation of Sediment Removal Alternatives: Ashland/NSPW Lakefront Superfund Site*, Anchor QEA, dated October 2012 ("Anchor Report") (Attachment 2-A).[2]

- *Critique of the National Contingency Plan Consistency of US EPA's September 2010 Record of Decision for the Ashland/Northern States Power Lakefront Site,* Gradient, dated October 11, 2012 ("Gradient Report") (Attachment 2-B).[3]

- *Technical Assessment of EPA's Comparative Analysis of Near Shore Dry Excavation and Site-Specific Failure Mechanisms*, Burns and McDonnell, dated October 2012 ("Burns Report") (Attachment 2-C).[4]

Because NSPW did not have an opportunity to previously comment on the Weston Report, and other new and material information that first appeared in the final ROD, it submits comments now for the record.[5] In addition, NSPW trusts that this new information will help inform the Agencies' own decision-making and that the parties can work together to identify a more reasonable, safe, and implementable remedy for the sediments at the Site.

### C. NSPW's Willingness to Cashout or Perform A Reasonable Alternative Remedy

For the reasons described in detail in the attachments, NSPW is not willing to perform a dry dredge. As a regulated entity, it would be imprudent for NSPW to undertake a remedy that presents an unacceptable safety risk to workers, and unacceptable risks to human health and the natural environment. Moreover, the dry dredge significantly increases the risk of exacerbating

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[2] Anchor QEA is a nationwide environmental consulting and engineering firm that specializes in the remediation of sediments.

[3] Gradient is a specialty environmental consulting firm with more than 25 years of experience developing effective solutions to complex environmental issues, both nationally and abroad, including many National Priorities List sites within U.S. EPA Region V.

[4] Burns & McDonnell is a full-service environmental engineering and consulting firm, with significant experience in soil and sediment remediation design. Burns and McDonnell has also won national honors for its Manufactured Gas Plant ("MGP") remedial design solutions, and leads the industry in complete MGP capabilities, from initial studies to final design-build site reclamation.

[5] Documents related to the remedy selection issue should continue to be added to the record because (1) the late issuance of the Weston Report prevented NSPW from submitting materials responsive to the Weston Report prior to the issuance of the ROD, and (2) the decision between the dry dredge and wet dredge remains at issue pending the results of a pilot. *See* 40 C.F.R. 300.825(a), (c). The agency may also want to consider seeking further comments from the public, since the public (including the affected community in Ashland) likewise did not have an opportunity to review and comment on the Weston Report, and the other new and material information that first appeared in the ROD, during the public comment period.

existing contamination, which is contrary to the goals of all concerned. Importantly, as a business which prides itself on sophisticated and rigorous risk analysis, NSPW views the dry dredge as too risky and entirely inconsistent with NSPW's commitment to safety and environmental protection. To the extent the Agencies want to implement the dry dredge, NSPW urges EPA to accept a reasonable cash-out offer from NSPW, which would allow the Agencies to perform the remedy themselves (while preserving NSPW's rights to seek contribution from other PRPs for their fair share of the sediment costs). Otherwise, NSPW will work with the Agencies to identify a reasonable, mutually-acceptable alternative remedy for the Site. While NSPW raises two possible alternatives below, NSPW continues to remain open to considering other reasonable, safe, and environmentally sound approaches that might be offered by the Agencies.

One potential alternative continues to be a wet dredge remedy for the Site. As you are aware, the ROD sets forth the possibility that a wet dredge could be performed at the Site and an ESD could be issued to allow for that approach. To date, however, NSPW and EPA have not yet agreed on how to measure achievement of any wet dredge performance standards. As set forth in NSPW's proposals in 2011, NSPW was willing to perform a wet dredge consistent with national best practices, but cannot agree to verification standards which, if strictly interpreted, would result in an unimplementable remedy.

Given the concerns about the dry dredge and the impasse previously reached in discussions over a wet dredge, NSPW has re-evaluated whether any other technical solutions exist that would meet the NCP criteria and resolve the environmental concerns at the site. One such option would be an enhanced confined disposal facility ("CDF"), or what the Company refers to as a permanent engineered shoreline. This option is not only implementable, safe and cost effective, but would also further promote recreational and navigational opportunities for the local community consistent with the City of Ashland's Waterfront Redevelopment Plan.

## D. Conclusion

NSPW has worked cooperatively with EPA and the State for many years toward developing an appropriate cleanup for the Site, and supports an appropriate risk-based cleanup of sediments.[6] Although NSPW is not willing to put its employees or contractors at risk, it is willing to (1) cash-out and contribute funds to EPA's performance of the dry dredge remedy, or (2) implement a more reasonable, safe, and environmentally and economically sound alternative remedy, provided that the Company's contribution rights are preserved.

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6 While NSPW is willing to perform a reasonable alternative remedy at the Site, it should be noted that the company continues to disagree with the underlying risk assessments performed at the site, and continues to assert that the harm, if any, at this site is divisible, and that other PRPs have substantial responsibility for site conditions.

We look forward to discussing these issues with you further, and to achieving a mutually agreeable resolution to these important matters.

Respectfully submitted,

Kelly E. Richardson
of LATHAM & WATKINS, LLP

cc: John Robinson, Supervisor, WDNR
Kristin Hess, Attorney, WDNR

# ATTACHMENT 1

# Ashland Lakefront Sediment Remediation

**Comparison of alternatives**

| **Dry Dredge** ($63.3-$77.1 million*) | **Wet Dredge** ($45.3-$64.7 million*) | **Permanent Engineered Shoreline** ($35.8 million*) |
|---|---|---|
| • No consultant has agreed to implement a dry dredge at the site due to significant implementability concerns and the risk of catastrophic and irreparable remedy failure (potential for basal heave, piping, boiling, failure of sheet pile wall, damage to aquitard upon installation of sheet pile wall, etc.). EPA's own contractor (Weston) acknowledged "significant worker/ equipment safety concerns" and several "fatal flaw failure mechanisms" that are unique to the dry dredge alternative. | • Wet dredging is the predominant sediment management technology at moderate-sized to large contaminated sediment sites around the world. Over the last two decades of environmental dredging, a range of best practice engineering and performance controls have been developed to minimize environmental impacts, including release of contaminants. | • Permanent Engineered Shorelines are a proven remedial technology, and have been successfully implemented at 40+ sites in the Great Lakes including sites involving containment of contaminated sediments. A Permanent Engineered Shoreline is particularly appropriate here, due to favorable site conditions, applicable state and local requirements and the work already underway in Kreher Park. |
| **RISKIEST AND UNSAFE.** The Dry Dredge poses a high risk of catastrophic and irreparable harm, increased risk of community exposure to air odors and emissions, and delays to the City of Ashland's redevelopment plans, due to the lengthy construction schedule. | **ACCEPTABLE.** The Wet Dredge can achieve environmental protection goals, is a proven approach under similar conditions, and does not pose the short or long-term negative effects on the community. | **ACCEPTABLE AND PROVIDES MOST SIGNIFICANT COMMUNITY BENEFITS.** A permanent engineered shoreline can achieve environmental protection goals, is a proven approach, and does not pose the short or long-term negative effects on the community that a dry dredge poses. It also is the only option that offers the City of Ashland an opportunity to create new additional parklands and to support its lakefront redevelopment plans. |

*Estimates provided in the 2010 Record of Decision. Could be +50% or -30% according to estimates.

| **2012 Evaluation of Superfund Criteria** | **Dry Dredge** As proposed in the Record of Decision | **Wet Dredge** with nationally recognized performance standards | **Permanent Engineered Shoreline** with nationally recognized performance standards |
|---|---|---|---|
| Protective of Human Health and the Environment | NO | YES | YES |
| Compliance With Other Applicable Laws | YES | YES | YES |
| Long-Term Effectiveness | NO | YES | YES |
| Meets Performance Standards | NO | YES | YES |
| Short-Term Effectiveness | NO | YES | YES |
| Implementability | NO | YES | YES |
| Cost | HIGHEST | MODERATE | LOWEST |
| Public Acceptance | NO | YES | YES |

# Ashland Lakefront Sediment Remediation

## ENVIRONMENTAL AND SAFETY RISKS OF DRY DREDGE

Northern States Power Company-Wisconsin (NSPW), an Xcel Energy company, supports a safe, environmentally sound, and implementable approach to the cleanup of contaminated sediments at the Ashland Lakefront Site. The "Dry Dredge" remedy selected in EPA's Record of Decision (or ROD), however, is not implementable, does not meet national recognized safety standards and may result in irreparable harm to human life and the environment.

There are safer, more effective, alternative remedies that could be implemented for the sediments at the site such as:

1. A permanent engineered shoreline, which would extend the adjoining park creating new park lands and would promote marina redevelopment.

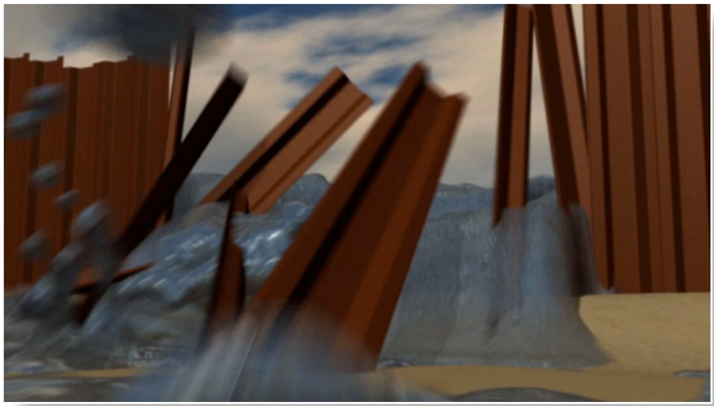
2. A wet dredge, consistent with nationally recognized best practices.

These approaches are safer, implementable, environmentally sound and more cost effective than a dry dredge.

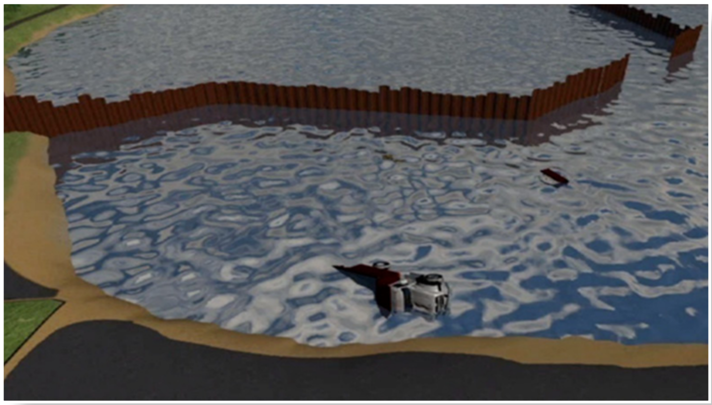
**What is a Dry Dredge?**

The near shore dry dredge excavation remedy selected for the site involves de-watering the near-shore part of Chequamegon Bay on Lake Superior (the largest freshwater lake in the world) by installing a sheet pile wall to hold back the lake, and dredging contaminated sediments from a quasi-dry lakebed. There are serious environmental and safety risks associated with this approach due to the unique conditions at this site. These conditions have been well documented by several nationwide environmental consulting firms. According to these firms, standard industry safety factors, established by Army Corps of Engineers and U.S. Navy, <u>can not be met under the dry dredge approach.</u>

The dry dredge poses unnecessary and irreversible risks to worker safety, the environment, and community.  Due to conditions such as basal heave, failure of the sheet pile wall, and other failures, contamination could mobilize and spread to new areas of the site and cause irreversible impacts on the regional hydrogeology. A dry dredge also poses safety risks to workers and the surrounding community and will require that public parks and facilities be closed for long periods of time.



Basal heave and/or failure of the outer sheet pile wall could lead to unsafe conditions for workers, potential loss of life, and complete and irreversible failure of the project.



Basal heave could potentially release groundwater contamination, which is currently held in place via artesian forces.

# Ashland Lakefront Sediment Remediation

**What is a Wet Dredge?**

Wet dredging is a process by which sediments are removed from under a body of water, with a dredge barge and an attached closable environmental hydraulic bucket with secure lips. The bucket removes sediment and discharges it to a sealed container on the barge, from which it is subsequently de-watered and treated or disposed.

Wet dredging technology has evolved over the past two decades and today uses state-of-the-art environmental controls and GPS technology to provide for precise removal of contaminated sediments.

Wet dredging is a proven remedial technology that has been used at a number of sediment sites around the country where similar contaminants and conditions are present.

NSP-Wisconsin has offered to perform a wet dredge following standard industry practices with reasonable performance standards to measure its success.

Substantial precedent exists for using wet dredging technology to remediate contaminated sediments.

Compared to a dry dredge, wet dredging is:

- Equally protective of the environment and can be completed faster and more cost-effectively
- Less disruptive to the public and local businesses, has fewer risks to safety and human health
- Significantly less costly
- The predominant sediment management technology at moderate-sized to large sediment sites around the county, including the Great Lakes

Any wet dredging remedy must be implementable and should be consistent with nationally-recognized best practices.


Environmental engineering controls such as turbidity silt curtains are highly effective means to contain and control dispersal of contaminants during wet dredging.


Wet dredging, coupled with engineering controls and GPS technology, is a proven remedy for addressing contaminated sediments in the Great Lakes.

# Ashland Lakefront Sediment Remediation

## PERMANENT ENGINEERED SHORELINE

**What is a permanent engineered shoreline?**

A permanent engineered shoreline is a desirable cleanup option for the near shore sediments. The option could be designed as an extension of the Kreher Park to support the City of Ashland's redevelopment plans by providing additional lakefront shoreline and community gathering spaces and safely contain dredged sediments preventing their re-entry into the waterway.

This option could be enhanced by:

- Using mass removal technologies
- Treating or disposing contaminated sediments
- Pumping and treating groundwater
- Require monitoring to ensure that contaminants are contained

A permanent engineered shoreline is an attractive option considering the unique conditions at the site, including the selected containment remedy for the on-land portion.

Permanent engineered shorelines are:

- Implementable and proven and have been successfully used at 40+ sites in the Great Lakes
- Protective of the environment and can be completed faster and more cost-effectively than any dredging option, with less disruption to the community and fewer risks to safety and human health
- An extension of containment already in place at Kreher Park
- The only option that would allow for planned extension of Kreher Park and which would complement the City of Ashland's redevelopment plans

By constructing all or part of the outer perimeter of the Permanent Engineered Shoreline as a bulkhead wall, a new vertical shoreline would be established that could be designed to accommodate access and docking by vessels and public boats. Similarly, a boat ramp could be incorporated to augment the Prentice Avenue boat ramp at a similarly accessible point.

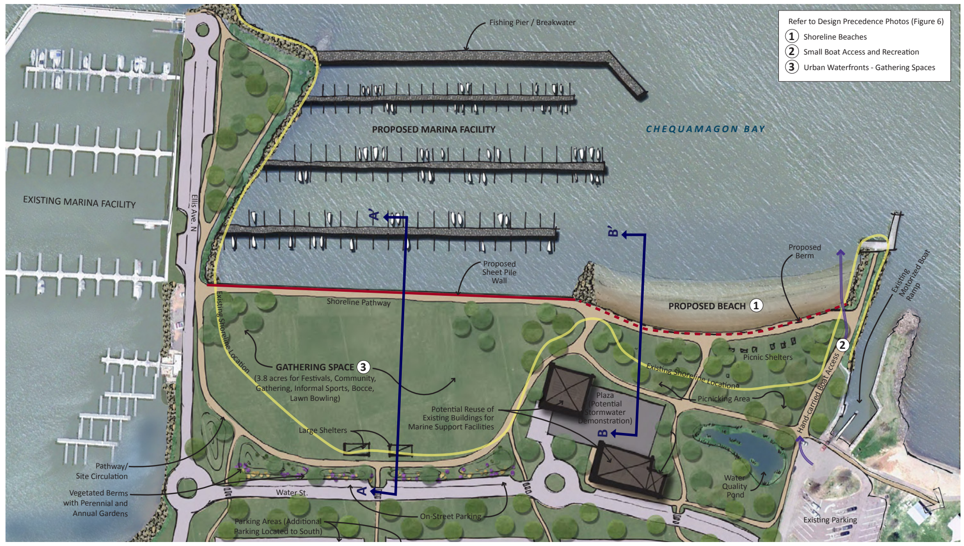
The grounds of Kreher Park could be extended outward over the surface of the area as enhanced public space, with options to include walking paths, native plantings, festival grounds and shoreline promenade, thus improving public access to this portion of the Chequamegon Bay shoreline.

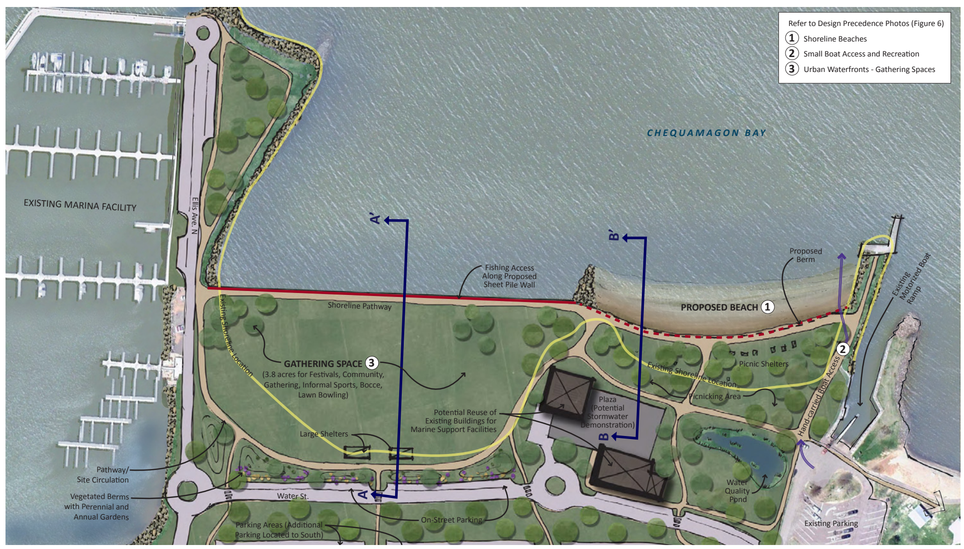
Because the existing usable land area at Kreher Park is limited, additional land area gained through the construction could be used to site a community building, or an educational installation.

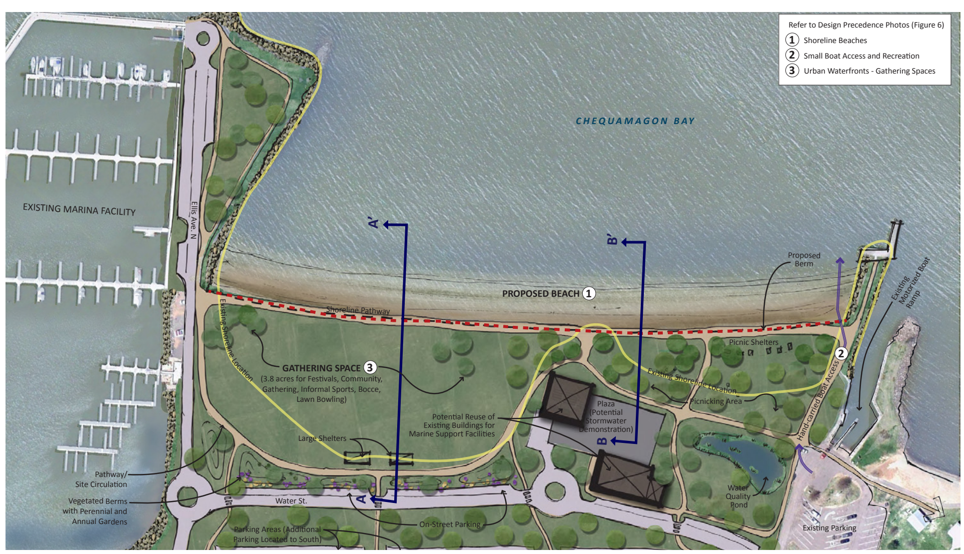
Some or part of the surface could be built to a lower range of elevations that allow for occasional or frequent inundation by lake water and configured to provide near-shore habitat area and function.

The Permanent Engineered Shoreline could be fashioned to represent a public example of industrial cleanup and environmentally sensitive remedial planning, which would dovetail with the area's sustainability intiatives.

## Permanent Engineered Shoreline Concepts



## What are the risks of a dry dredge?

- **Basal heave:** The area is currently in equilibrium, with the weight of the lake water and sediments pushing down on the clay aquitard, and artesian pressures from groundwater pushing upward. Removing water and sediments during a dry dredge will upset this balance, and may cause the aquifer to burst through the aquitard. If this occurs, the consequences would be irreparable and potentially catastrophic. Once the clay liner is breached, it cannot be repaired and the area could never be returned to pre-basal heave conditions.

  Breach of the aquitard could result in flooding of the area while workers and equipment are present, causing serious safety risks. It could also mobilize the presently-contained groundwater underneath the site resulting in new contamination, or recontamination of areas that have already been cleaned up.

- **Containment failure:** In order to dewater the near-shore area to allow for dry dredging, the EPA's Record of Decision requires a sheet pile wall to be driven into the aquitard, which will drive contamination from the sediment into the aquitard and could create basal heave or other containment failures (see diagrams below). Additionally, the sheet pile wall may not withstand the extreme winter conditions in Lake Superior.

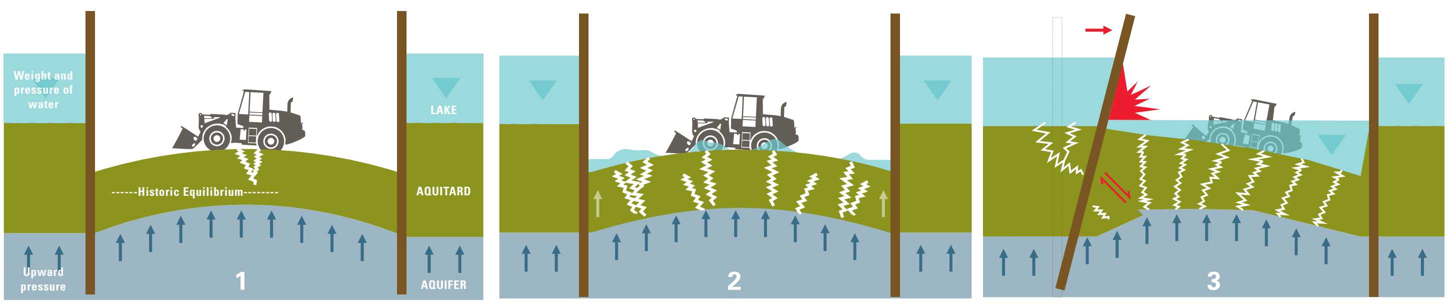
- **Timing:** The dry dredge will take longer to implement than other remedies, resulting in greater disruption to the community, longer closure of Kreher Park, and greater interference with City of Ashland's plans for redevelopment of the area.

- **Community Impacts:** Significant noise and air emissions. Long-term closure of Kreher Park.

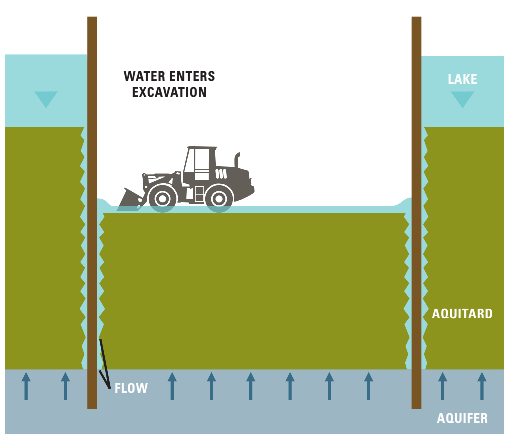
### Dry Dredge Consequences

- Irreparable environmental damage
- Serious injuries or loss of human life
- Significant costs and delays, and community distruption

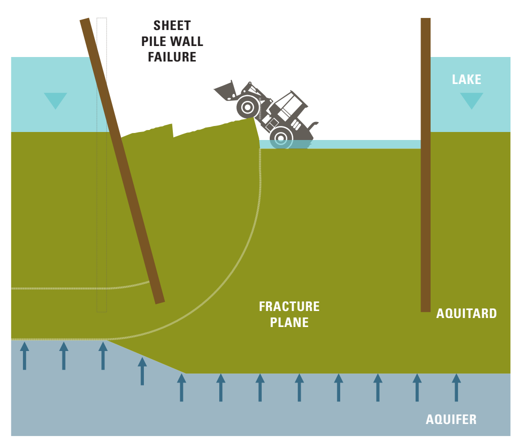
### Probable Environmental and Safety Scenarios




**(1)** uplift of bottom soil along sheet pile walls and weakening foundation soil which can lead to **(2)** rupturing from artesian uplift and uncontrolled flow into excavation, which can lead to **(3)** loss of support to sheet pile wall due to the weakened foundation soil from uplift, and potential sidewall failure




Loss of of restraint due to pressures of retained soil and free water, weakened further by artesian pressures, is another possible cause of wall failure




Installation of sheet pile creates damaged 'slot' through aquitard allowing piping through weakened soil into excavation area.

# ATTACHMENT 2

# ATTACHMENT 2
# NSPW/Ashland Superfund Site Sediment Remedy Summary Report

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## I. EXECUTIVE SUMMARY

Northern States Power Company ("NSPW") supports an appropriate risk-based cleanup of contaminated sediments at the Ashland/Northern States Power Lakefront Superfund Site ("Site"), provided that any such remediation is safe, environmentally and economically sound, and implementable. NSPW, however, cannot agree to implement the near shore dry excavation (or "dry dredge") remedy selected in the Record of Decision ("ROD") as the preferred remedy for the Site, because the remedy involves a novel application of dry dredging technology, is inconsistent with nationally recognized and observed safety factors, risks potentially catastrophic and irreparable environmental damage, and seriously endangers human life and safety. The dry dredge is also unimplementable and cost ineffective. *See* Site Fact Sheet, at 1.

As set forth herein, there are serious environmental and safety risks associated with the dry dredge, including basal heave, containment failure, piping, fracturing of the aquitard, and the release of pressurized water into the "dry" excavation area—all of which can lead to irreversible environmental degradation, safety risks, and even loss of human life. *Id.*, at 2-3. In addition, in a dry dredge environment, there will be stronger odors and greater risk of air emissions in excess of health and safety standards, potentially creating exposure risks to workers and the community. *Id.* The dry dredge is also expected to take longer to implement than other remedies, resulting in greater disruption to the community, longer closure of Kreher Park, and further delay of the City of Ashland's plans for redevelopment. *Id.*

It was not until after the close of the Feasibility Study, that many of these serious safety risks were first brought to NSPW's attention by its consultants. These concerns were raised to EPA around the time that EPA issued its Proposed Remedial Action Plan ("Proposed Plan" or "PRAP") for the Site, when EPA first indicated a preference for the dry dredge remedy. NSPW provided comments on the public record on the Proposed Plan. After the public comment period closed, it appears that EPA commissioned its consultant, Weston, to study the safety risks associated with the dry dredge. Weston finalized a report in November of 2009 entitled *Technical Memorandum regarding the Conceptual Geotechnical Assessment for Sediment Removal* ("Weston Report"), but that report was not shared with NSPW until after EPA issued its final record of decision ("ROD") in 2010. As a result, neither NSPW nor the public (including the local community) has had an opportunity to review and publically comment on the Weston Report. After the ROD was issued, NSPW consulted with three separate consultants, Anchor QEA LLC,[1] Gradient,[2] and Burns & McDonnell,[3] who have now had an opportunity to review

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[1] Anchor QEA is a nationwide environmental consulting and engineering firm that specializes in the remediation of sediments. Anchor QEA is nationally recognized for coastal development, engineering, landscape architecture, dredging management, resource and regulatory agency permitting, water quality, habitat restoration and construction management, and has conducted work for a range of clients, including public agencies. Michael Whelan, the primary author of the Anchor Report, has 15 years of experience as a civil, environmental and geotechnical engineer, and holds a Master of Geotechnical Engineering Degree from the Massachusetts Institute of Technology, and a Master of Environmental Engineering Degree from the Georgia Institute of Technology. Mr. Whelan's

the Weston Report. Upon this review, all three consultants concluded that the dry dredge identified in the ROD is unimplementable and cannot be performed consistent with nationally recognized safety standards. Those conclusions are discussed further below and in the attached separate reports (see attachments A – C, hereto). In addition, AECOM, URS Corporation, and Foth Infrastructure & Environment LLC ("Foth") also previously expressed serious concerns regarding the safety and implementability of the dry dredge at the Site, making a total of *six* consultants that have rejected the dry dredge component at the Site.

Weston itself has recognized that there are fatal flaw failure mechanisms that are unique to a dry dredge at this Site, but without any support, Weston concluded in its report, based on a "preliminary conceptual analysis," that "near-shore, bay bottom sediments likely can be safely removed using dry excavation techniques, assuming that conceptual planning, final design engineering and implementation of the construction work are all properly executed." However, the Weston Report provides *no* specific guidance on how this would be accomplished to ensure that the dry dredge remedy is safely implemented. NSPW's three expert consultants have each determined that the Weston Report overestimates the stability of Site sediments, and fails to recognize the true risks of the dry dredge remedy. *None* of NSPW's expert consultants have

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experience includes management, design and oversight of numerous sediment remediation, restoration, monitoring and development projects around the United States. In addition to Mr. Whelan, the Anchor team consists of several other members that have similarly extensive experience with contaminated sediment sites.

[2] Gradient is a specialty environmental consulting firm with more than 25 years of experience developing effective solutions to complex environmental issues, both nationally and abroad, including many National Priorities List sites within U.S. EPA Region V. Principal Scientist Kurt Herman, the primary author of the Gradient Report, holds a Master of Engineering Degree in Environmental Engineering from the Massachusetts Institute of Technology and has more than 13 years of experience in environmental consulting—including the evaluation of PAHs and tar in sediments at numerous former manufactured gas plant and wood-treating sites.

[3] Burns and McDonnell is a full-service environmental engineering and consulting firm, with significant experience in soil and sediment remediation design. Burns and McDonnell has also won national honors for its Manufactured Gas Plant ("MGP") remedial design solutions, and leads the industry in complete MGP capabilities, from initial studies to final design-build site reclamation. Matthew Cox, the primary author of the Burns Report, has over 14 years of experience in environmental consulting, and is a certified Professional Engineer and Professional Geologist in several states, including Wisconsin. Mr. Cox specializes in evaluating the environmental fate and transport of contaminants at MGP, hazardous waste, and petroleum contaminated sites, and has managed investigations and remediations at MGP sites throughout the midwest. Although the report is signed by Burns and McDonnell staff, numerous other firms were consulted in preparing the report, including DCI Environmental, Inc., Newfields, Hartman Associates, Mike Palermo Consulting, RPS Evans Hamilton, Inc. and Coast and Harbor Engineering.

indicated a willingness to perform the dry dredge remedy as presented in the ROD, due to safety and environmental risks.

Accordingly, NSPW has serious concerns regarding the safety and implementability of the dry dredge remedy, and is concerned that the environmental and safety risks, and immense costs, are not justified by any measurable benefits—particularly considering that other proven remedies are available to safely and effectively address sediment conditions at the Site.

The ROD does recognize the potential for a wet dredge remedy of the Site, if NSPW can demonstrate that wet dredging can meet certain performance standards set forth in the ROD. NSPW previously proposed to perform a wet dredge pilot study to EPA, consistent with the application of best demonstrated technologies and practices, but EPA rejected that proposal and, in NSPW's view, has interpreted the performance standards in the ROD in a manner that renders the wet dredge approach illusory and unimplementable. NSPW can only agree to perform a reasonable and implementable wet dredge, that is consistent with practices at other sediment cleanup sites across the country. In Section II.E below, we outline the history of wet dredge discussions to date, and how NSPW would approach a reasonable wet dredge cleanup.

However, given that NSPW and EPA have not agreed to date upon how to design and measure success for an implementable wet dredge remedy, NSPW has asked its consultants to re-evaluate whether other remedies might exist for the sediments that would be effective in terms of environmental protection, without the risks associated with dry dredging. One such option is an enhanced confined disposal facility ("CDF") or "engineered shoreline." While CDFs were considered during the FS stage, they were not given much serious consideration due to concern that no legal mechanism would allow a CDF to be constructed at the Site. However, as described in Section III.C.3 below, NSPW has identified several legal mechanisms that would in fact allow an engineered shoreline to be constructed at this Site. Moreover, given that the Kreher Park remedy consists of hot spot removal and containment, construction of an engineered shoreline as an extension of Kreher Park—where dredged materials could be placed—is a consistent site-wide approach to the cleanup. NSPW envisions that any engineered shoreline would be enhanced compared to CDFs considered during the FS, based on newer technologies that are now more common—and that would involve mass removal over time. An engineered shoreline could also provide benefits to the community in the form of additional public park lands and improvements supporting redevelopment, and recreational and navigational activities.

NSPW supports remediation of sediment at the Site, and is interested in working cooperatively with the agencies and community to implement a remedy that does not present serious risks to the workers, environment, and community. In light of the enormous risks and potential for irreversible harm associated with the dry dredge, however, the company is not willing to place its employees or contractors at risk, or risk exacerbating environmental conditions at and around the Site.

Accordingly, for the reasons set forth herein, NSPW requests that:

**1.** the agencies include this submittal and attached reports in the administrative record and consider reopening the record to allow an opportunity for other members of the public to comment on the Weston Report; and

**2.** EPA accept the company's cash-out offer and perform the remedy of its choosing, or allow NSPW to implement a safe and effective alternative remedy to the dry dredge.

## II. BACKGROUND & PROCEDURAL HISTORY

Below, we provide a short background regarding when the dry dredge remedy was first identified for consideration as a remedy at the Site, information describing how concerns about the dry dredge remedy were first raised, and a summary of events leading us up to present day regarding why NSPW is now submitting new and additional information regarding its concerns with the dry dredge remedy.

### A. Early Consideration Of A Dry Dredge Remedy

The dry dredge proposed in the ROD is a hybrid remedy that involves dry excavation of near shore sediment and wood debris using conventional earth-moving equipment, coupled with the mechanical or hydraulic wet dredging of sediments further offshore. ROD, at 75. In order to perform dry excavation of the near shore sediments, it is necessary to construct a barrier around the area to be remediated, remove the waters of Lake Superior from the isolated area, and continually pump seepage from the lake and groundwater to maintain sediment conditions that are as dry as possible.

While dry excavation was briefly mentioned as a possible remedy component during the remedy screening process, it was considered to be a "very high cost" remedy. Burns Report, at A-1 (citing the Comparative Analysis of Alternatives Technical Memorandum, dated Oct. 2007 ("CAA Memo")). Accordingly, the agencies were initially focused on other alternatives, primarily the CDF, which the CAA Memo concluded "would provide the most long-term benefit at the least cost and with the fewest short-term technical implementation issues." *Id.*, at A-2. However, in late-2008, the agencies reversed course and required that site-wide and near shore dry excavation alternatives be added to the Feasibility Study ("FS") report, pursuant to EPA's authority under the AOC. The potential for catastrophic remedy failure, including basal heave, was not evaluated during the FS process. Prior to the approval of a final FS, EPA met with the National Remedy Review Board ("NRRB" or "Board"), which recommended the dry dredge in January 2009, without substantive analysis or critique. The Board's decision failed to even mention potential failure mechanisms, constructability issues, safety concerns, environmental protection, or compliance with National Contingency Plan ("NCP") criteria, stating only that

> [t]he Region [5] identified dry dredging as the preferred alternative for dredging the product waste distributed within the wood material. The Board notes the difficulty that wet dredging poses, especially in light of the associated potential for contaminant releases during the operation. Therefore, the Board supports dry dredging of the contaminated overburden material and underlying

product to the extent practical (200 feet from the shoreline, as presented).

Because the dry dredge alternative was injected into the FS process contemporaneously with the Board's review, the dry dredge was not fully vetted at the time the Board issued its recommendation, and its decision did not consider the possibility of basal heave or other potential remedy failures because those issues had not yet been identified.

### B. NSPW First Identified Concerns About the Dry Dredge

NSPW expressed concerns regarding the environmental and safety risks associated with dry excavation at the Site to EPA at several meetings, beginning as early as May 2009. Burns Report, at A-5. In July 2009, EPA staff indicated that they also had concerns with the safety of the remedy, and would be willing to reconsider the viability of the dry excavation component if NSPW presented the technical basis for its objections. *Id*., at A-6. At EPA's request, NSPW timely submitted a constructability review of the dry excavation component described in the PRAP on August 17, 2009, which raised numerous safety and environmental concerns associated with dry dredging at the Site, including basal heave, design flaws in the proposed containment system, and the increased risk of plume mobilization and community exposure to volatile organic compounds. *Id.* The constructability review also attached a preliminary opinion by Foth, raising significant concerns regarding the dry dredge. *See* Preliminary Geotechnical Review – Sheet Pile Wall Installation for the Ashland/NSPW Lakefront Site, dated June 1, 2009 (analyzing dry excavation and concluding that elevated artesian pressures beneath the excavation area could result in instability and remedy failure). NSPW also raised similar concerns in both its initial PRAP comments—which were guided by input from one of its consultants, Gradient, and also timely submitted on August 17, 2009—and its supplemental PRAP comments, submitted April 20, 2010.

### C. Issuance of the ROD

On October 4, 2010, EPA publicly issued a ROD, dated September 2010, that identified the dry dredge (SED-6) as the preferred sediment remedy for the Site and referenced the Weston Report in support of the decision. However, the ROD also contemplated wet dredging (SED-4) as an alternative remedy, if a pilot test were to demonstrate that wet dredging could meet the applicable performance standards. Specifically, the ROD stated that "if a pre-design pilot test for wet dredging of the near shore area is conducted and indicates that dredging rather than dry excavation within the near shore area will attain the established performance standards and can be conducted in a manner protective of human health and the environment, then EPA, in consultation with WDNR, will recommend that an alternative remedy (dredging) be implemented for both near shore and outer shore sediments and EPA will publish its decision in an ESD." ROD, at 76. The "performance standards [set forth in the ROD], or other equivalent standards approved by EPA, would need to be met in order for the pilot test to be judged a success." ROD, at 98.

### D. Weston Report

Neither EPA nor WDNR publicly commented on the issues raised in the company's constructability review or NSPWs comments on the Proposed Plan in August of 2009; however, unbeknownst to NSPW at the time, and in response to the company's specific concerns, EPA apparently engaged Weston after the close of the public comment period to evaluate the risk of basal heave associated with implementation of the dry dredge at the Site. *Id.* Although Weston's analysis was summarized in the Weston Report, dated November 20, 2009, EPA never notified NSPW of the existence of the report and the report was not made publicly available at that time. *Id.* In fact, NSPW did not learn of the report until EPA referenced it in the ROD, which was published *more than a year after* NSPW submitted its August 23, 2009 constructability review demonstrating the impracticability of dry excavation at the Site. *Id.* As a result, the company was unable to comment on Weston's conclusions prior to the close of the public comment period on the PRAP and prior to the issuance of the ROD; accordingly, neither NSPW, nor the public generally, had an opportunity to publically comment on the risks associated with the dry dredge, or the "solutions" proposed by Weston.

### E. Negotiations Over A Wet Dredge Pilot Study

Shortly after the issuance of the ROD, NSPW began working with the agencies to develop an Administrative Order on Consent ("AOC"), a Statement of Work ("SOW"), a Pre-Design Pilot Test Work Plan ("Work Plan"), and a Performance Standards Verification Plan ("PSVP") (together, "Pilot Plans") that would collectively set forth the requirements for the design, implementation, and evaluation of the pilot test for a wet dredge, as allowed for in the ROD. For several months, NSPW and EPA engaged in extensive good faith negotiations regarding the terms of a mutually agreeable pilot study to determine whether wet dredging of near shore Site sediments could (i) meet the performance standards set forth in the ROD, and (ii) be conducted in a manner protective of human health and the environment. To facilitate a prompt agreement, NSPW expended significant resources to develop the Pilot Plans; however, EPA rejected the company's proposed approach. From NSPW's perspective, the agency interpreted the performance standards in the ROD in a manner that would render performance of a wet dredge illusory, unimplementable, and inconsistent with best demonstrated practices and technologies used at other sites throughout the country. Further progress on sediment remediation stalled when NSPW and the agencies could not agree on appropriate performance standards verification metrics. At that time, NSPW and the agencies agreed to temporarily suspend sediment negotiations, in order to focus on negotiating a partial consent decree whereby the Company would agree to perform the landside remedial design/remedial action for the Site.

### F. Negotiations Over An Uplands RD/RA Consent Decree

Since that time, the parties have been working on various issues, including the successful negotiation of the recently executed *Uplands Consent Decree Between The United States, Wisconsin, NSPW, and the Bad River and Red Cliff Bands of the Lake Superior Tribe of Chippewa Indians* ("Uplands CD"). Even though other parties contributed significantly to the uplands contamination, NSPW was the *only* party to agree to perform the cleanup of the groundwater and soils on the on-land portion of the Site—a $40 million dollar commitment. With the Uplands CD now lodged and awaiting court approval, the company is returning its attention to sediment issues. At this time, the Company wants to share with EPA and other stakeholders new and additional information it now has regarding serious concerns three separate consultants have identified with the dry dredge remedy.

### G. NSPW's Current Position Regarding the Sediment Remedy: The Company Is Unwilling To Perform A Dry Dredge Remedy, But Is Willing To Implement A Reasonable Alternative Remedy At The Site

In the attached expert reports and as summarized further below, NSPW explains why the dry dredge remedy is not implementable, will put workers and the community at risk, will risk exacerbating environmental problems at the Site, and why it would be arbitrary and capricious for EPA to require any PRP to implement the dry dredge remedy at this Site.[4] A comparative analysis of potential remedies demonstrates that there are serious safety, environmental, constructability, and cost issues associated with the dry dredge. Numerous failure mechanisms unique to the dry dredge (including, without limitation, basal heave, sheet pile collapse, and mobilization of the Copper Falls plume)—could lead to catastrophic and irreparable environmental damage if a dry dredge is performed. As a result, none of the three expert consulting firms contacted by the Company have indicated a willingness to perform the dry dredge as designed, and all have warned that the potential modifications to the dry dredge remedy proposed by Weston cannot meet industry safety standards.

NSPW does not wish to put its contractors or employees in jeopardy, or risk exacerbating environmental problems at the Site, particularly considering that there are safer, proven remedies that are equally as protective as the dry dredge (if not more so). Given these concerns, NSPW respectfully requests EPA to either (1) accept NSPW's proposed cash-out offer if EPA wants to perform the dry dredge remedy itself and take on the risks identified below and in the attached reports, or (2) allow NSPW to implement a reasonable alternative remedy.

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[4] Pursuant to the NCP, EPA is required to consider comments submitted by interested persons after the close of the public comment period to the extent that the comments "contain significant information not contained elsewhere in the administrative record file which could not have been submitted during the public comment period and which substantially support the need to significantly alter the response action. All such comments and any responses thereto *shall* be placed in the administrative record file." 40 C.F.R. 300.825(c) (emphasis added). In addition, EPA may add documents to the administrative record file after a ROD is issued where such documents "concern a portion of a response action decision that the decision document . . . reserves to be decided at a later date." 40 C.F.R. 300.825 (a). Because the Weston Report was not issued until after the ROD was signed, and the ROD contained other material new information not previously disclosed, NSPW could not have submitted documents that respond to the Weston Report and the new information prior to the issuance of the ROD. Further, the ROD reserves the decision between the dry dredge and wet dredge pending the results of a pilot; accordingly documents related to this remedy selection issue, including the instant comments, should continue to be added to the record.

## III. IT WOULD BE ARBITRARY AND CAPRICIOUS TO REQUIRE RESPONSIBLE PARTIES TO PERFORM A DRY DREDGE IN LIGHT OF THE SIGNIFICANT SAFETY AND ENVIRONMENTAL RISKS ASSOCIATED WITH THE DRY DREDGE, COMPARED TO ALTERNATIVE REMEDIES

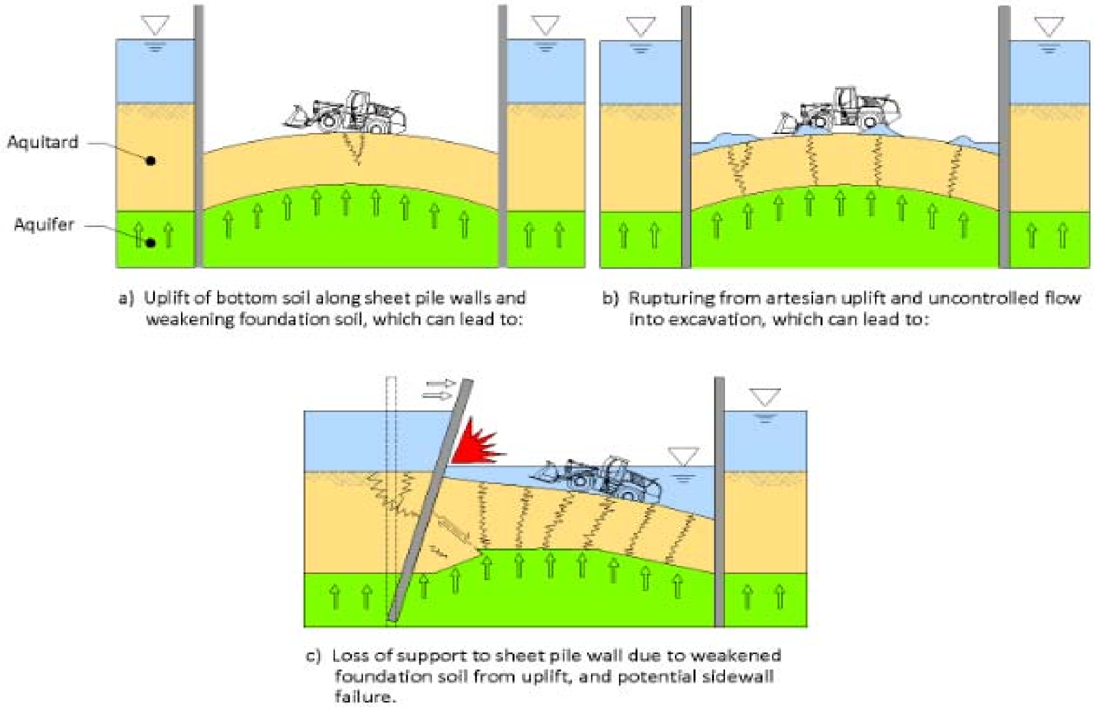
NSPW is concerned that the ROD's analysis of potential remedies did not fully consider the serious safety, environmental, constructability, and cost concerns associated with the dry dredge, or provide any technical basis indicating that such concerns can be effectively mitigated. Upon reviewing the Weston Report, NSPW's consultants have identified numerous failure mechanisms unique to the dry dredge (including, without limitation, basal heave, sheet pile collapse, and mobilization of the Copper Falls plume)—any one of which could lead to catastrophic and irreparable environmental damage. As a result, none of the three expert consulting firms contacted by the company have indicated a willingness to perform the near shore dry excavation remedy as described in the ROD or Weston Report, nor is the company aware of any similar site where this remedy has been successfully implemented under similar conditions. Further, Weston did not identify any concrete measures that can be employed to successfully mitigate the unique risks associated with the dry dredge, and the potential modifications to the dry dredge remedy proposed by Weston would not mitigate those risks consistent with industry safety standards. *See e.g.*, Burns Report, at 1-2.

### A. The Dry Dredge Poses A Number Of Serious Risks

The dry dredge is unsafe for the following reasons, which are explained in further detail in the attached fact sheets and reports:

- **The Dry Dredge Increases The Risk Of Basal Heave And Bottom Instability:** Removing bay water and sediments overlying the Copper Falls aquifer poses significant potential for bottom upheaval and basal heave failure. Anchor Report, at 4-5. If such failure were to occur, the artesian conditions in the underlying aquifer could blow water upward through the excavation bottom and lead to a complete collapse of the containment wall, resulting in potentially catastrophic risks to worker safety and construction disruption. In addition to presenting unsafe conditions for workers, a basal heave failure could also lead to dislodgment or mobilization of previously contained sediments and NAPL (which is currently contained by artesian conditions), leading to irreparable damage to the aquitard and exacerbation of Site conditions. Anchor Report, at 5. In such a case, there would be no corrective action available – the damage to the aquitard is irreversible.

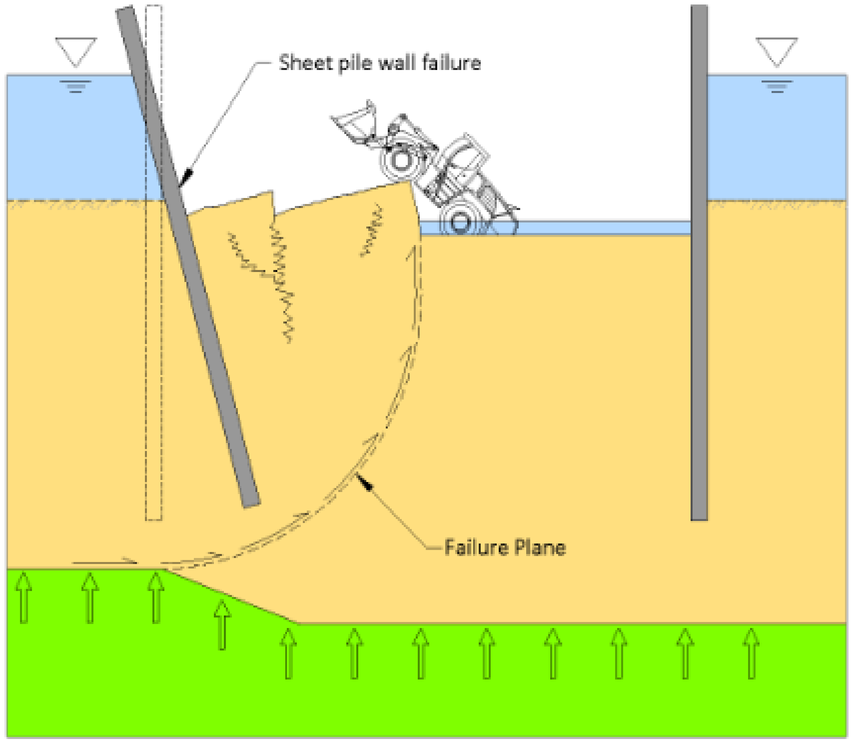
Fig. 1.  Depiction of Basal Heave Failure




- **The Dry Dredge Risks Exacerbating Environmental Conditions Due To NAPL Migration:** To the extent an event such as basal heave were to occur, mobilization of the NAPL plume within the aquifer is also likely to occur, and could create new exposure pathways or otherwise exacerbate conditions at the Site. *Id.* Additionally, the installation and extraction of sheet piling for containment purposes during dry excavation may damage the integrity of the aquitard, creating pathways that could promote NAPL migration. *Id.*, at 46. High energy waves passing over the top of the containment wall and/or precipitation events may also cause migration of NAPL within the dry excavation area, further complicating cleanup. Burns Report, at 4-8.

- **The Dry Dredge Risks Sheet Pile Wall Collapse:** High energy wave conditions, or deep cuts to the aquitard required to install containment could result in failure of the containment wall, the consequences of which would be catastrophic to workers and equipment within the dry excavation area. Anchor Report, at 44-45. Integrity of the containment structure may also be a concern in the event that unforeseen subsurface conditions or other scheduling delays require dry excavation to be conducted over multiple seasons, as the ROD design does not appear to account for effects of ice damage to the containment wall. To assure a safe design, a more robust (and expensive) cofferdam structure is likely required; however, even a cofferdam (which was not analyzed in the Feasibility Study or ROD), may not meet the necessary safety factor to ensure stability. *Id.*, at 45.

Fig. 2. Depiction Of Sheet Pile Wall Collapse

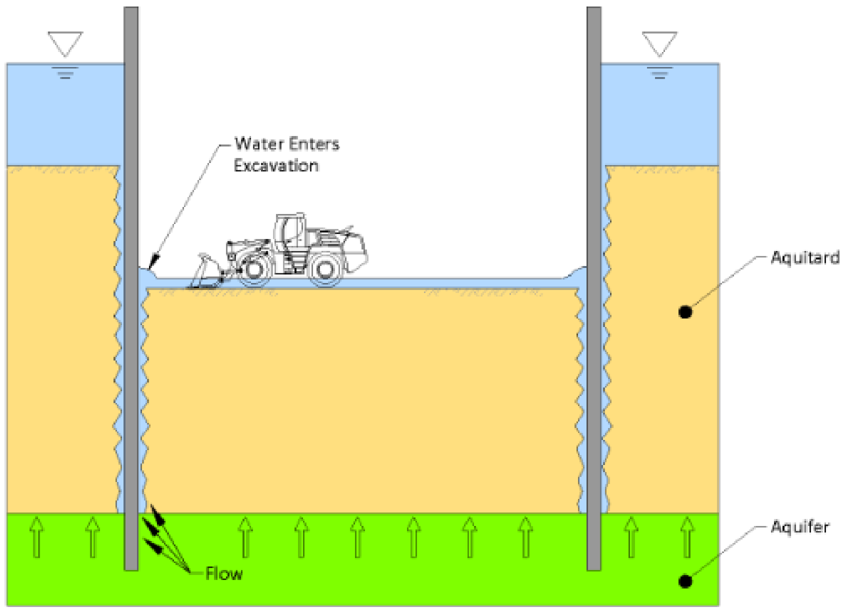



Loss of restraint due to pressures of retained soil and free water, weakened further by artesian pressures, is another possible cause of wall failure.

- **The Dry Dredge Poses Greater Risks To Workers And The Community, Including Increased Risk Of Exposure To Volatile Organic Compounds, Such As Benzene And Naphthalene:** Even absent catastrophic remedy failure, the dry dredge poses increased occupational risk, as compared to other alternatives. Burns Report, at 4-12 – 4-13. For example, dry excavation is associated with increased airborne emissions of volatile compounds, especially benzene and naphthalene, into the work area and surrounding community resulting in increased risk of potential exposure. *Id.* While vapor suppression techniques, such was a water blanket or foam, are available, such measures compromise the dryness of the excavation bottom (triggering the need for specialized equipment) and defeat the purpose of performing a dry excavation. *Id.*

- **The Dry Dredge May Not Be Implementable Due To Various Site-Specific Failure Mechanisms:** The ROD also fails to acknowledge numerous other Site-specific circumstances that affect the implementability of the dry dredge, including (1) piping caused by installation of the sheet pile wall; (2) the impact of wind, waves, and ice on the sheet pile wall; (3) the need for exploratory trenching to locate and remove obstructions; (4) the effect that the stiff composition of the aquitard may have upon efforts to install the sheet pile wall; (5) the potential for difficult sheet pile driving conditions to result in compromised interlocks; (6) the potential that scour caused by the wall will mobilize existing sediment contaminants; and (7) technical difficulties associated with dewatering the "dry" remedial area. Burns Report, at §§ 4-5.

Fig. 3. Depiction of Piping Caused By Sheet Pile Installation




Installation of sheet pile creates damaged "slot" through aquitard allowing piping through weakened soil and into excavation area..

Consequently, "it is apparent that under existing conditions, [the dry dredge] cannot be performed to meet industry standard criteria or safety objectives." Burns Report, at 1-3.

### B. A Dry Dredge Cannot Be Performed At This Site Consistent With National Safety Standards, Even With Weston's Proposed Modifications

The Weston Report, which analyzed only a subset of the above-listed concerns, acknowledged that the "structural stability of the sheet pile wall, excavation bottom blowout, and piping of bay bottom sandy sediments are significant worker/equipment safety concerns and represent potential 'fatal flaw' failure mechanisms," but ultimately concluded that a modified dry dredge could be a viable remedy for the Site if certain additional data were collected and the remedy were designed appropriately. Weston Report, at 2. Specifically, Weston proposed a modified "segmented" approach (which was not incorporated into the ROD) intended to improve the safety and stability of the dry dredge by subdividing the dry excavation area into a patchwork of individual 150 x 200' cells; however, in doing so, Weston employed certain methodologies and assumptions that collectively operated to overestimate the stability of the proposed segments. Anchor Report, at 33-34 ("The results . . . demonstrate that even when using the terms of Weston's analysis, the allowable size of dry excavation cells that would be needed to achieve stability have likely been overestimated. . . . [T]his overestimation is a consequence of the assumptions and approach used by Weston in developing its soil profile, soil properties, and analytical method."); Burns Report, at 1-2 ("Weston's conclusions infer a degree of safety that is not warranted by the analysis completed.").

By contrast, all of the experts consulted by NSPW dispute Weston's conclusions, and agree that the dry dredge is unimplementable and unsafe—even with Weston's proposed modifications. *See* Anchor Report, at 57 ("[T]he unique conditions and challenges of the Site render it an extremely poor candidate for the dry excavation method."); Gradient Report, at 4 ("[The dry dredge] is a costly and potentially dangerous remedy that is unprecedented for such an open water Great Lakes setting that should not have been selected."); Burns Report, at 1-2 ("The [dry dredge] remedy required by the ROD cannot be performed safely . . . and cannot meet NSPW's objectives based on nationwide industry safety standards as designed.").

These experts' specific concerns with the dry dredge and Weston's modifications are discussed in detail in attachments A-C, and are summarized as follows:

- **The Weston Report Relies On Overly-Optimistic Assumptions That Favor Dry Excavation, Even Though Existing Data Is Limited And Indicates Significant Variability In Site Conditions**: Because existing data is limited and highly variable, it is uncertain whether Site conditions will permit a successful dry dredge. Given this uncertainty, it is important to consider *all* site conditions that are likely to be encountered, and design the remedy to withstand the most difficult conditions that could realistically exist. This is particularly true considering that remedy failure could put the lives of workers (as well as the environment and millions of dollars of equipment) at risk. But instead of employing a reasonable degree of conservatism to account for the uncertainty created by the relative lack of subsurface data, Weston consistently employed aggressive assumptions regarding lake water elevation; elevation of surficial sediment; elevation of contact between surficial sediment and the aquitard; aquitard thickness; aquitard composition; the depth of dredging that will be required below the wood waste layer, soil unit weight; and the undrained shear strength of bottom soils. In doing so, Weston ignored the *actual* range of conditions that have been identified through field work to date, and failed to consider whether the dry dredge will be safe under all conditions that are reasonably expected to be encountered. As just one example, Weston's analysis relies on assumptions that the aquitard is thicker and stronger than it is already known to be in certain areas, contrary to existing exploration data. Anchor Report, at 45 ("Weston assumed an aquitard thickness of 28 feet, although one nearshore exploration showed it to be only 23 feet, in which instance the sheetpile would extend well into the aquifer . . . ."). These assumptions are described in greater detail in the attached reports, which unanimously conclude that when reasonably conservative, site-specific assumptions are used, it becomes clear that "[dry dredging at the Site, as proposed in the ROD and as modified by Weston is] inadequate from an engineering design standpoint and unimplementable in the field without severe risk to environmental conditions and to human safety." Anchor Report, at ES-3.

- **The Weston Report's Novel Methodology For Assessing The Potential For Basal Heave Overestimates The Degree Of Stability That Can Be Expected During**

**Dry Excavation:** Weston erroneously dismissed basal heave as an issue of mere "usability," and consequently underestimated the potential damage associated with this condition. Basal heave is a symptom of aquitard failure; accordingly, if basal heave occurs, it is likely to be accompanied by a significant reduction in soil strength, which could lead to flooding of the "dry" excavation area, mobilization of the NAPL plume, and potential catastrophic loss of containment. Anchor Report, at 27. Given the scale of these consequences, "it is imperative that . . . regulatory representatives . . . not underestimate the potentially damaging effects of this condition." *Id.*, at 28.

- **Weston's Excavation Bottom Upheaval Analysis Overestimates The Stability Of The Excavation Bottom, And Applies Minimum Safety Factors That Are Below Standard Industry Guidance:** In assessing the potential for bottom upheaval, Weston made several assumptions that overestimate the safety of the dry dredge. First, Weston departed from standard and industry-accepted guidance by including soil shear strength in its basal heave analysis. Weston's inclusion of soil shear strength creates the appearance of an "improvement" in stability of the excavation, without addressing or accounting for variability in the soil shear strength mobilized at the time of failure, or the geometry and dimensions of the failure mass—both of which affect the stability and safety of the proposed cells. Anchor Report, at 30-31. Accordingly, "the [proposed] 150-foot by 200-foot dry excavation cells [are] much less safe than reported, and ha[ve] the potential to catastrophically fail if implemented." *Id.* This overestimation of shear strength is compounded by the fact that Weston targeted a minimum safety factor of only 1.2, which is much lower (and less safe) than the industry standard of 1.5. *Id.*, at 31.

- **Weston's Basal Heave Shear Failure Instability Analysis Is Flawed:** Weston's novel methodologies and aggressive assumptions regarding the soil profile, soil properties "the allowable size of dry excavation cells that would be needed to achieve stability have likely been overestimated." Anchor Report, at 33. In other words, the Site would need to be divided into cells much smaller than 150 by 200 feet in order to attempt to make the dry dredge safer—but even then would not render the remedy safe or environmentally sound. "Using smaller dredge cells would require repeated episodes of sheet pile installation and excavation work, … would have significant effects on project schedule, cost, and technical implementability, and could exacerbate site conditions." *Id.*, at 56.

- **Weston Ignored The Potential Damage To The Aquitard Resulting From A Segmented Approach:** A "segmented" approach requires the repeated installation of individual sheet pile "cells," which could potentially damage the integrity of the aquitard, and increase the risk of bottom blowout, basal heave, and other failure mechanisms. In addition, because the sheet piling must be driven deep into the lakebed to allow the cells to withstand the anticipated soil, water, wave and wind forces exerted by Lake Superior, the segmented approach risks *breaching* the aquitard, and injecting contaminated sediments into the groundwater (particularly considering the relative lack of data regarding the precise thickness of the aquitard throughout the dry dredge area). Moreover, even if the aquitard is not completely penetrated, the installation and extraction of multiple individual cells risks (i) causing soil instability that will increase the likelihood of bottom blowout, basal heave, and other failure mechanisms, and (ii) exacerbating Site conditions by pushing surface contaminants deep into the aquitard, to areas that are presently clean. Anchor Report, at 38.

Fig. 4. Remedy Failures Associated With Dry Dredging

| Key Design Flaws And Associated Risks of Remedy Failure | | Recommended Minimum Safety Factor | PASS/FAIL AT THIS SITE |
|---|---|---|---|
| **Bottom Upheaval** | • Bottom upheaval is the tendency of the ground surface to be pushed upward in response to elevated artesian pressures created when the pressure above the aquifer is reduced due to dewatering and dry dredging. Bottom upheaval could cause fracturing of the aquitard and the release of pressurized water into the excavation, with irreversible environmental damage and catastrophic risk to workers. | 1.5 | **FAIL** |
| **Shear Instability** | • Shear instability is a condition where the bottom soils are weakened and undergo shear failure that can destabilize the excavation's supporting walls and cause instant flooding of the work zone, placing the safety of workers at risk and resulting in the suspension and redistribution of contaminated sediments over a much wider area. | 1.5 | **FAIL** |
| **Sheet Pile Embedment** | • The sheet pile wall must be installed deep into the lakebed, so that it can adequately resist pressures from water and soils outside the excavation area; however, the aquitard is too thin to permit the wall to be installed to a safe depth without penetrating the aquitard (even if forces from wind and waves typical of Lake Superior storm events are not considered). If the piles are not installed deep enough, the wall could collapse, causing flooding in the excavation area and serious risk to workers; however, breaching the aquitard risks weakening the soils further and injecting surface contaminants into the groundwater plume. In addition, installing sheet piling at any depth risks exacerbating contamination by pushing contaminants deeper into the aquitard, to areas where they do not presently exist. | 1.5 | **FAIL** |

In sum, "the unique conditions and challenges of the Site render it an extremely poor candidate for [a dry dredge]," and Weston's proposed modifications are insufficient to render it workable or safe. *Id.*, at 50. Due to the risk of basal heave, and other catastrophic failures, the dry dredge is not only "undesignable to accepted engineering standards, but . . . also [potentially] unbiddable to the contracting community due to the associated financial and human health risk." *Id., at 57.* Safety is a priority on any project, and is one of NSPW's core values. As such, NSPW does not wish to put its employees or contractors at risk, nor risk exacerbating environmental conditions at the Site, when other more reasonable and effective remedies could be performed at the Site. NSPW is also very concerned that *none* of the consultants who have examined the project at its request have indicated a willingness to perform the remedy. Anchor Report, at ES-2, 48-50; Gradient Report, at 4; Burns Report, at 6-1, 7-1.

### C. The Dry Dredge As Modified By Weston Is Significantly Different Than The Dry Remedy Selected In The ROD, And Requires An Explanation Of Significant Differences Or ROD Amendment

Moreover, Weston's approach is significantly different from the dry dredge described in the ROD, and will require an ESD, if not an amended ROD. Weston concludes that "it would be possible to install an in-water sheet pile wall approximately 200 feet from the shoreline as presently conceptualized *as long as sheet pile walls perpendicular to this wall separated by no more than 150 feet were also installed to subdivide the dry excavation footprint into 150 feet by 200 feet cells before dewatering of any given cell to complete the dry excavation is permitted*." Weston Report, at 7 (emphasis added). However, this proposal represents a fundamental modification that affects the scope, performance, environmental impacts, safety risks, and cost of the dry dredge in multiple ways that were not previously considered in the FS or ROD. For example, the modified sheeting system creates multiple, entirely new technical considerations that will need to be addressed, including the removal of residuals alongside the containment cell walls that otherwise could have been removed but for the obstructions created by the containment system. In addition, construction of the small cells contemplated in the Weston Report will substantially increase the cost and duration of constructing the remedy, and the space constraints associated with a segmented approach will further limit productivity. Burns Report, at 5-6. Due to the length of the construction season in the Ashland area, the Weston modifications will also likely result in the extension of construction over multiple seasons, further preventing the use of public facilities. *Id.*

Should EPA proceed without properly considering these issues, EPA would be responsible for any remediation costs associated with the segmented approach that were otherwise avoidable or unnecessary, including costs associated with mitigating any remedy failure. *See e.g., U.S. v. Burlington Northern R'wy Co.*, 200 F.3d 679 (10th Cir. 1999) (finding EPA improperly failed to issue an ESD or amend the ROD before pursuing deviations from the ROD remedy that resulted in a 61% cost increase, and clarifying that EPA bears liability for any demonstrable excess costs resulting from such actions that would not otherwise have been incurred).

### D. The Dry Dredge Fails To Meet NCP Criteria, But NSPW Is Willing To Implement Other Alternative Remedies That Would Meet NCP Criteria

The NCP requires compliance with specified criteria to ensure the selection of remedies that benefit human health and the environment; however, the Company is concerned that the ROD's comparative analysis of these criteria does not adequately address the safety and environmental risks of the dry dredge. Moreover, the Company believes that when all of the technical information currently available is considered, the NCP criteria effectively "screen out" the dry dredge alternative, as a result of the safety and constructability problems described above and in the attached consultant reports. The following subsections of this Summary Report identify risks associated with dry dredging that were not previously accounted for in the ROD analysis, and set forth the reasons why other remedies, such as wet dredging or a permanent engineered shoreline, will better fulfill the objectives of the NCP and agencies' goals for the Site.

### 1. Legal Standard And Overview Of Applicable NCP Criteria

The purpose of the remedy selection process is to implement remedies that eliminate, reduce, or control risks to human health and the environment. To achieve this purpose, the National Oil and Hazardous Substances Pollution Contingency Plan, 40 C.F.R. Part 300 ("NCP") mandates a specific and detailed process for remedy selection. In order to be eligible for selection, a remedy must first satisfy two "threshold" criteria: (i) overall protection of human health and the environment, and (ii) compliance with Applicable and Relevant or Appropriate Requirements ("ARARs"). 40 C.F.R. § 300.430(f)(1)(i)(A).

All remedies that satisfy the threshold criteria are then evaluated against five "balancing" criteria: (i) long term effectiveness and permanence; (ii) reduction of toxicity, mobility, or volume through treatment; (iii) short-term effectiveness; (iv) implementability; and (v) cost. 40 C.F.R. § 300.430(f)(1)(i)(B). While a remedial action must be protective of human health and the environment and comply with all applicable ARARs in order to be selected, a remedy must also provide the best balance of trade-offs among alternatives in terms of these five primary balancing criteria. 40 C.F.R. § 300.430(f)(1)(ii)(D).

- **Long Term Effectiveness and Permanence** requires the agency to consider (a) the magnitude of residual risk remaining for untreated waste or treatment residuals remaining at the conclusion of the remedial activities; and (b) the adequacy and reliability of controls, such as containment systems and institutional controls, that are necessary to manage treatment residuals and untreated waste. 40 C.F.R. § 300.430(e)(9)(iii)(C).

- **Reduction of Toxicity, Mobility, or Volume** addresses the statutory preference for remedies that employ treatment.

- **Short-Term Effectiveness** requires the agency to assess short-term impacts associated with the remedy, including: (a) short-term risks posed to the community during implementation of a remedy; (b) potential impacts on workers during the remedy; (c) potential environmental impacts of the remedy; and (d) time until protection is achieved. 40 C.F.R. § 300.430(e)(9)(iii)(E).

- **Implementability** requires the agency to analyze (a) technical feasibility, including technical difficulties and unknowns associated with construction and operation of the technology, reliability of technology, and ease of undertaking; (b) administrative feasibility, including coordination and approvals or permits necessary; and (c) availability of services and materials. 40 C.F.R. § 300.430(e)(9)(iii)(F).

- **Consideration of Costs** requires the agency to assess the relative cost of each remedy under consideration, including an analysis of capital costs, annual operation and maintenance costs, and net present value of such costs. 40 C.F.R. §

> 300.430(e)(9)(iii)(G). In order for a remedy to be selected, it must be cost-effective.[5] A remedy is cost-effective if its costs are proportional to its overall long-term and short-term effectiveness and its effectiveness at reducing toxicity, mobility, or volume. 40 C.F.R. § 300.430(f)(1)(ii)(D).

Finally, "modifying" criteria of State and community acceptance must also be considered. 40 C.F.R. § 300.430(f)(1)(i)(C). The State's position and key concerns related to the remedies, as well as the State's comments on ARARs should be considered. An assessment of community acceptance should include a determination of which remedies interested persons in the community support, have reservations about, or oppose. 40 C.F.R. § 300.430(e)(9)(iii)(H-I).

Based on the above criteria (and information previously submitted and new information included in the attached expert reports), the dry dredge remedy is not the appropriate remedy for this Site.

### 2. The Dry Dredge Fails The Protectiveness Requirement Because It Risks Catastrophic And Irreparable Harm To The Environment

The NCP requires a remedy to "adequately protect human health and the environment, in both the short- and long-term, from unacceptable risks." The ROD failed to adequately consider the risks and consequences of catastrophic remedy failure, or consider that if the dry dredge remedy fails, the damage to human health and the environment would far exceed the relatively minor risk of chemical exposure that is currently posed by the Site. Gradient Report, at 9; Anchor Report, at 4-5 ("The consequence of excavation failure are numerous and range from construction problems to irrevocable environmental damages, to potential loss of human life."). Likewise, the ROD did not address the concern that basal heave or altered hydrodynamics could mobilize the Copper Falls plume, and create new exposure pathways that could exacerbate the environmental problems at the Site and potentially complicate or prevent successful cleanup.[6] *Id.* Given these serious risks, the dry dredge fails to pass the threshold, as it presents a greater risk to human health and the environment than is currently posed by Site sediments.[7]

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5 "[C]ost is a critical factor in the process of identifying a preferred remedy. In fact, CERCLA and the NCP require that *every* remedy *must* be cost-effective." Gradient Report, at 14. (quoting EPA guidance). Remedy alternatives may thus be "screened out" if they provide equivalent effectiveness and implementability as another alternative that is less costly. 40 C.F.R. 300.430.430(e)(7)(iii).

6 Because the "protectiveness" analysis "draws on the assessments of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs," a remedy (like the dry dredge) that results in unacceptable short-term risks or cross-media impacts should be excluded under this prong. 40 C.F.R. § 300.430(e)(9)(iii).

7 This is particularly true considering that the ROD concluded that Site sediments posed a significant risk to human swimmers and waders based on *hypothetical* exposures to oil sheens that were presumed, without proof, to have originated from NAPL in sediments—even though such sheens have been so rarely observed that they have never been tested. Because the risk assessment is based on hypothetical estimates that do not present a realistic

### 3. The Dry Dredge Fails The Long-Term Effectiveness Prong Because It Risks Catastrophic And Irreparable Harm To The Environment

The NCP requires that remedies be "assessed for the long-term effectiveness and permanence they afford, along with the degree of certainty that the alternative will prove successful." 40 C.F.R. § 300.430(e)(9)(iii)(C). But whether the dry dredge will prove successful at the Site is highly uncertain, due to the significant potential for catastrophic remedy failure. As the largest freshwater lake in the world, the Site exhibits unique properties that are not suited for a dry dredge. These unique conditions, the relative paucity of Site data (and difficulty associated with collecting further data for fear of damaging the aquitard), and the fact that this remedy has not been implemented at any similar sites, call into serious question the effectiveness and certainty of a dry dredge, as well as the ROD's failure to seriously consider the potential environmental damage that could result from the dry dredge.

Based on the information developed since the issuance of the ROD, it is now clear that Site conditions are not conducive to dry dredging. Significant uncertainty exists regarding parameters crucial to the success of a dry dredge, such as the thickness and composition of the aquitard. Further, the limited data collected indicates that efforts to construct a stable sheet pile wall (or dredge cells) will likely necessitate driving the sheet pile *through* the aquitard in certain locations, with the resulting damage likely to increase the risk of catastrophic remedy failure. Other conditions, such as severe weather conditions, icing, and the enormous open water fetch resulting from the sheer size of Lake Superior, are expected to further increase the probability of catastrophic failure by placing additional strain on the containment wall that would necessitate extremely stable soils to support the wall (which likely would not exist if the integrity of the aquitard is compromised). Accordingly, there are serious reasons to believe that the dry dredge could significantly and irreversibly damage the environment, and should be disfavored. *See* Sections III.A and III.B *supra*. Such problems could be avoided by implementing a wet dredge, permanent engineered shoreline, or other remedy.

### 4. The ROD Reached Flawed Conclusions Regarding The Relative Potential Of Each Remedy To Achieve Reductions In Toxicity, Mobility or Volume Of Contaminants

The ROD concluded that the dry dredge would better reduce the toxicity, mobility, or volume of contaminated sediments because wet dredging will leave behind increased residuals, due to the difficulty of wet dredging sediments and free product co-located with wood waste. ROD, at 69. But the ROD analysis did not acknowledge residuals associated with the dewatered dry dredge area, or consider the impacts of potential flooding due to seepage, boiling, quick sediment, and/or basal heave.

As the ROD acknowledges, the sediments within the targeted near shore excavation area will not be "dry." ROD, at Appx. N-2, pg. 51. Nonetheless, the ROD overlooks the fact that (1)

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measure of the actual risk posed by sporadic sheens, the true risks posed by Site sediments have not been accurately characterized (or properly balanced against the potential consequences of the dry dredge remedy, set forth in attachments A-C), and are likely overestimated.

"dry" excavation will require some control of wet residuals from wet sediments within the excavation area, and (2) managing "dry" excavation residuals will be significantly more difficult and expensive than managing wet dredge residuals only. *See* Burns Report at 5-2 – 5-3 (summarizing residuals management issues that are expected to occur during "dry" excavation, including impacts of moisture in the dry due to boiling and quick sediment; the need to use a water blanket or wet foaming to suppress high benzene and other volatile emissions; entrainment of suspended residuals in the shallow water blanket; and possible redistribution of suspended residuals due to precipitation events).

In addition, selecting the dry dredge on the basis of residuals management efficiency ignores the physical requirements and potential environmental impacts and costs associated with the dry dredge. Dry excavation will require significant site preparation, dewatering to a depth of one to three feet below the level of the contamination, depressurization, and the subsequent removal of sediment to the contamination depth. *Id.*, at 5-5. Given the present uncertainty regarding how much depressurization will be required, and the extent to which such depressurization is likely to mobilize NAPL in sediments, the ROD's suggestion that the dry dredge will achieve the greatest reductions in toxicity, mobility or volume lacks a rational basis.

#### 5. The Dry Dredge Fails The Short-Term Effectiveness Prong Because It Risks Catastrophic And Irreparable Harm To The Environment

The NCP requires a remedy to be protective of the community and workers during implementation. 40 C.F.R.§ 300.430(e)(9)(E). Implementation of a dry dredge would pose numerous risks to workers and the community. But while the ROD cursorily acknowledged that "there are increased concerns with worker safety in a dry excavation scenario," it summarily dismisses these concerns, reasoning that "dry excavation is a commonly used technology and there are effective and reliable mitigative measures that *will be developed* during the design phase for the remedial action." ROD, at 70 (emphasis added). Based on the 2008 FS, the ROD also assumed that dry and wet dredging could be completed within similar timeframes, such that short-term risks would be similar. However, the dry dredge had not been engineered beyond the conceptual level at the time the FS was drafted and approved, and multiple additional concerns that were not accounted for in the ROD have since been identified. Burns Report, at Appx. A; *see also* Sections III.A and III.B, *supra*.

NSPW is thus concerned that many of the "potential threats to human health and environment" associated with the dry dredge were not adequately addressed in the ROD, such as:

- Catastrophic remedy failure(s), including but not limited to, basal heave, bottom instability, containment wall failure, and mobilization of the NAPL plume;

- Increased risks to worker health and safety attributable to the longer construction schedule required for dry excavation compared to other remedies, (including increased transportation or construction-related injuries or fatalities);[8]

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[8] For example, existing data suggest that the increased duration of the Dry dredge remedy is associated with a 23% increase in the likelihood of injury and fatality, exclusive of any

- Health risks and air quality impacts posed by increased worker and community exposure to VOCs; and

- Impacts to the community associated with a longer construction schedule, including increased duration of noise impacts, odor impacts, truck traffic, loss of Kreher Park use, and delayed implementation of the City of Ashland's Waterfront redevelopment plan. [9]

In light of the above factors, the ROD's conclusions regarding the relative short-term risks of each remedy should be re-assessed.

### 6. The Dry Dredge Fails The Implementability Prong Because Existing Site-Specific Data Indicates It Is Not Constructible

The ROD includes minimal analysis of the implementability of the dry dredge, despite the fact that the dry excavation of an entire embayment in the largest surface water lake in the world is an unprecedented proposal that is subject to significant technical feasibility concerns. While the ROD described dry excavation as "difficult to implement," it failed to address the potential for catastrophic failure, or analyze whether dry excavation is technically feasible—even though technical feasibility is a key factor in determining implementability. *See* 40 C.F.R. § 300.430(e)(9)(iii)(F). It also did not consider the technical challenges posed by the generation of millions of gallons of contaminated lake water that will need to be stored and treated, after de-watering. Burns Report, at 5-7. These omissions are particularly concerning, considering that all three experts consulted by NSPW questioned whether the dry dredge is implementable. Burns Report, at 6-1 ("Precedent shows dry excavation as proposed by EPA at Ashland would be very difficult to implement, may not be safe, and may not be as protective to human health and the environment as performing the work using an alternative technology."); Anchor Report, at ES-2 – ES-3 ("The sediment remedy envisioned by the ROD does not appear to be an implementable solution and presents a significant risk to worker safety and construction success. . . . [The dry dredge is] inadequate from an engineering design standpoint and unimplementable in the field without severe risk to environmental and to human safety."); Gradient Report, at 11-12 (critiquing Weston's failing to consider serious weather-related stressors, including wind, wave and ice action, that are expected to negatively affect the implementability of the dry dredge).

Moreover, a review of the existing precedent confirms that the dry dredge is not an appropriate remedy, given the unique conditions in Lake Superior. While the ROD references several "precedent" sites where dry dredging was performed, the listed sites are not representative of conditions at the Site. Burns Report, at 6-2; Gradient Report, at 11-13. For

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additional risk associated with catastrophic failure. By contrast, the risk of exposure to sediment-related contamination cited in the ROD, which is overly-conservative to the extent that it relies on hypothetical estimates of sheen concentrations, in lieu of actual data, is only 1x $10^{-5}$ suggesting that the actuarial risk of incurring a fatality during the remedy far exceeds the potential cancer risk of such exposure.

[9] While the ROD currently estimates that the dry dredge will take only two years longer than wet dredging, that schedule is likely to be expanded, due to the considerable technical difficulties associated with implementing the dry dredge. Burns Report, at 5-4 – 5-5, 5-7.

example, many of the listed projects do not appear to involve contaminated sites, and feature maintenance, rather than environmental, dredging. *Id.* To the extent that the listed sites involved environmental remediation, none involved volatile contaminants and similar open water site conditions as Ashland. *Id.* Even among sites that were of similar size, the area of remediation tended to be shallow and had less fetch, as compared to the Site. *Id.*

By contrast, sites that *are* similar suggest that dry excavation is likely to be problematic. For example, the Willow Run Creek Project at Tyler Pond, which involved dry excavation of sediments contaminated with PCBs and PAHs, was plagued by numerous difficulties, including (1) difficulty installing sheet pile containment due to subsurface obstructions, including an active water line that had to be relocated, (2) air emissions associated with constituents of concern, (3) inadequate strength of stabilization material, due to the water and oil contents of the sediments, and (4) frequent exceedances of state-imposed air emissions standards. *Id.* Similarly, one of the three environmental dredging projects cited in the ROD was unable to meet its performance standards, and was stopped due to geotechnical stability concerns similar to those posed at the Ashland Site, with complete excavation of the NAPL-affected till deemed infeasible due to concerns about the stability of the sheet pile wall, and the potential for breaching the underlying aquifer. Gradient Report, at 11-12.

In the absence of a meaningful evaluation of the technical feasibility of dry dredging at the Site, selection of the dry dredge is not supported by the record, particularly considering the special challenges associated with a large dewatered open work area that could result in the loss of structures, equipment, or lives.

#### 7. The Costs Of The Dry Dredge Are Grossly Disproportionate To Any Potential Benefits

Under CERCLA and the NCP, a remedial alternative may not be selected unless it is "cost-effective." 42 U.S.C. § 9621(b)(1); 40 C.F.R. § 300.430(f)(1)(ii)(D). A remedy is cost-effective only "if its costs are proportional to its overall effectiveness." 40 C.F.R. § 300.430(f)(1)(ii)(D). A cost-effective analysis must determine if a remedy offers a reasonable value for the money in light of the results it will achieve, and the requisite proportionality will not be found where the difference in effectiveness is small but the difference in cost is great. 55 Fed. Reg. 8728 (March 8, 1990). A remedy should not be selected if its costs are "grossly excessive compared to the overall effectiveness." See 40 C.F.R. § 300.430(e)(7)(iii).

According to the ROD, the dry dredge will cost approximately $32 million more than wet dredging, and $41.3 million more than a CDF. Moreover, given the range of accuracy of the ROD estimates, the actual cost of the dry dredge could be up to 50% higher than estimated in the ROD. Because the dry dredge will cost substantially more than other equally effective alternatives, *and* has significant implementability concerns, it is clearly not cost-effective, and should have been screened out from further consideration—particularly considering that this cleanup may ultimately be funded in part by natural gas utility customers and the taxpayers of the City and County of Ashland.

Fig.5. Comparative Cost Analysis of The Dry Dredge, Wet Dredging, and CDF Alternatives

| Alternative | Estimated Cost | Potential Cost Savings Of Alternative Remedy |
|---|---|---|
| CDF | $35.8 Million | Up to $41.3 Million |
| Wet Dredge | $45.3 - $64.7 Million* | Up to $31.8 Million |
| Dry Dredge | $63.3 - $77.1 Million* | None |

* Ranges are based on different removal and treatment technologies (e.g., hydraulic versus mechanical dredge, landfill versus thermal treatment). Estimates could be 50% higher.

### 8. The ROD Analysis Overestimates Community Acceptance Of The Dry Dredge

The ROD indicated that the community largely supported the dry dredge; however, such comments are meaningless since the impacts that the community will experience during dry excavation, including the risk of increased public exposure to odors and airborne contaminants, and disruption of public facilities and services (such as closure of the marina, boat launch, RV Park, etc.) have not been published (or even endorsed).

Moreover, certain members of the community, including the City of Ashland, have expressed concern about basal heave, and urged consideration of alternative remedies that are safe, effective, and cost-efficient. *See, e.g.*, Comment Letter from Edward Monroe, Mayor of the City of Ashland, and Rolland Peterson, City Council President, to Patti Krause, EPA Community Involvement Director, dated August 11, 2009 ("City PRAP Comments"), at 1. The City has also emphasized that "it is important that the cleanup (1) be protective of human health and the environment," (2) "be protective of the neighborhood," particularly with respect to the release of odors, and (3) "advance the goals and objectives of the City's Waterfront Development Plan." *Id.* In addition, the City acknowledged the issue of basal heave, and indicated that it "would like EPA to review and consider these concerns during the selection of the method of cleanup." *Id.* Collectively, these concerns suggest that the City, rate-payers, and community members likely will favor an alternative remedy, such as an enhanced permanent engineered shoreline, that is protective, cost-efficient, and enhances redevelopment goals.[10]

### 9. There Are Other Remedies, Such As A Wet Dredge Or Permanent Engineered Shoreline, That Would Meet The NCP Criteria

a. Wet Dredge

In contrast to the dry dredge, the wet dredge alternative complies with NCP criteria, and avoids many of the safety and environmental concerns associated with the dry dredge. Wet dredging is a proven remedial technology that would remove contaminated sediments from the Site, *without* constructing a containment wall or dewatering the near-shore part of Chequamegon

[10] NSPW also understands that the County of Ashland has concerns regarding the safety and implementability of the ROD remedy.

Bay. Rather, sediments in the entire impacted sediment area, both near-shore and off-shore, would be removed—without draining the lake—using a dredge boat and attached hydraulic shovel. Using this method, sediments would be dredged from the lakebed, discharged to a sealed container on the boat, de-watered in Kreher Park, and then either treated or disposed. "[T]there is extensive precedent for the common use of wet dredge technology for environmental remediation, demonstrating its implementability. As expressed in the 2009 PRAP comments (pp. 32-35, 210-0154), this includes sites in US EPA Region V and sites contaminated with NAPL and PAHs. Further, over the last three decades of environmental dredging, a range of near- and far-field engineering and performance controls have been developed to minimize short-term environmental impacts, including control of NAPL releases . . . from wet dredging." Gradient Report, at 12. "A well-planned and properly conducted wet dredging program will . . . meet performance standards in a manner that is equally, if not more, protective of human health and the environment" compared to dry dredging. Anchor Report, at 49. In addition, wet dredging can be completed more quickly and cost-effectively than dry dredging, with less disruption to the community and fewer risks to safety and human health.

The ROD recognized that wet dredging is protective of the environment, but favored dry dredging due to concerns regarding the management of wet dredge residuals. But the ROD overestimated this concern, and certainly did not balance it appropriately against the risk of catastrophic remedy failure that could occur if a dry dredge is implemented. Not only did the ROD fail to similarly consider the impact of residuals associated with *dry* excavation (such as might occur with incomplete dewatering or when excavating in the vicinity of the sheet pile wall), it also ignored the wide range of engineering and performance controls ("best practices") that have been developed to minimize environmental impacts during wet dredging, including control of NAPL releases. *See* ROD, at 68; Burns Report, at 5-2 – 5-3, 5-5. When all of the available evidence is considered, the wet dredge is more protective, effective, safer, and less costly than the dry dredge, and thus better satisfies the purpose of the NCP criteria—particularly when the short-term impacts of the dry dredge are taken into account. Anchor Report, at 49 ("A wet dredging program avoids the dangers of harm to the environment and human health that are posed by the dry excavation method.").

Moreover, the experts consulted by NSPW *all* concluded that a wet dredge remedy could be successfully implemented at the Site—provided that reasonable performance standards and measures of achievement can be established, consistent with wet dredging performed at other sites across the country. See e.g., Anchor Report, at 49. However, in prior negotiations related to the wet dredge pilot, EPA interpreted the ROD's performance standards in a manner that rendered the wet dredge unimplementable, leading to a breakdown in negotiations. Gradient Report, at 5 ("The [wet dredging] alternative has been rendered technically impracticable based on the Performance Standards US EPA set in the ROD.")

For example,

- EPA sought to measure compliance with the performance standards by sampling at the base of the dredge excavation; rather than within the habitat restoration layer—an overly-conservative approach that ignores any attenuation provided by the restorative layer, and measures compliance at a depth in which benthic invertebrates are not likely to reside. Gradient Report, at 23.

- EPA sought to tie compliance to a 22 mg/kg "not to exceed" level, obviating the SWAC approach,[11] increasing the likelihood that statistical outliers will control the remedy, and compounding the conservatism of the preliminary remedial goal and cleanup levels. Id., at 24.

- EPA insisted that there can be "no sheen" during the wet dredge, and interpreted this to require the installation of multiple sheet pile walls around wet dredge units—even when silt curtains or other alternatives would adequately protect against sheen, *without* the environmental risks and unnecessary costs that sheet pile walls could create at this Site. Gradient Report, at 15.

NSPW previously offered to perform a wet dredge, consistent with nationally-recognized best technology; however, EPA rejected the Company's proposed Pilot Plans and instead strictly interpreted the performance standards in the ROD in a way that would render a wet dredge approach illusory and unimplementable.

b. Permanent Engineered Shoreline

Given NSPW's unwillingness to perform an unsafe and unimplementable dry dredge, and EPA's insistence on measures of performance for a wet dredge that would render a wet dredge unimplementable as well, another option for this Site may be a permanent engineered shoreline which "could be designed for the Site in a way that is safer, cost effective, and in full compliance with environmental protection and site restoration goals while simultaneously supporting local community redevelopment opportunities." Anchor Report, at 51. Like the wet dredge, an engineered shoreline avoids the safety and environmental problems associated with the dry dredge remedy, but has the added benefit of providing substantial cost savings *and* the potential to complement the City's redevelopment plans by expanding Kreher Park. Construction of a permanent engineered shoreline is an implementable, proven technology for the Site, and similar containment facilities have been successfully implemented at over 40 sites in the Great Lakes, alone. In sum, not only is a permanent engineered shoreline protective of the environment, but it can be completed faster and more cost-effectively than any dredging option, with less disruption to the community and fewer risks to human health and safety. Enhancements could also be added to significantly reduce the total mass, toxicity, and mobility of pollutants within the containment, such as designing a permanent engineered shoreline with a DNAPL collection system that could effectively make it an extension of the Kreher Park remedy; enhancing the berm and/or surficial cover layers with an internal reactive organic carbon layer to augment the chemical isolation function of the facility; designing the shoreline to accommodate

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[11] The SWAC approach refers to the use of a surface-weighted average concentration as a target cleanup level, which is an appropriate and standard approach to risk-based cleanup, and has been adopted at numerous sites within EPA Region V. When collecting environmental data, there is natural variability in the data collected; accordingly, the presence of one or more samples in excess of the target may not necessarily represent a true difference from the expected value. A SWAC, which describes an average sediment concentration throughout a target area, is intended to provide a more realistic estimate of "real-world" exposure and avoids having one or more "outlier" samples drive the remedial action and associated costs.

the mass removal of selected sediments at the Site and/or adding cement or other in-situ additives to stabilize the contained sediment mass. Anchor Report, at 50; Gradient Report, at 16.

While CDF alternatives were considered in the ROD, a permanent engineered shoreline of the type proposed by NSPW was not. Further, in evaluating the CDF options, the ROD mistakenly concluded that CDFs could not be permitted by WDNR under Wisconsin law, and therefore could not comply with the NCP requirement of compliance with ARARs.[12] ROD, at 67. However, based on a plain reading of the applicable statutes, Wisconsin law does not categorically preclude construction of a CDF or engineered shoreline in Lake Superior,[13] and there is ample precedent for CDFs in the Great Lakes region—including at least two aquatic CDFs that were authorized in Wisconsin Great Lakes waters via legislative lake bed grant (Renard (a/k/a Kidney Island) and the Milwaukee Harbor CDF). Gradient Report, at 13.

In addition, there are several other legal means by which a CDF could be authorized, including (1) approval of a bulkhead line by WDNR under Wisconsin Statute Section 30.11; (2) a lease of lake bed from the Board of Commissioners of Public Lands under Wisconsin Statute Section 24.39, or (3) a lake bed grant by the Wisconsin Legislature, pursuant to Article IX, Section 1 of the Wisconsin Constitution.

The ROD also criticized CDFs on the ground that sediments within a CDF would be left untreated; however, the ROD failed to consider the myriad controls that are available to ensure proper containment of sediments within a CDF, or potential enhancements that could be added to achieve mass removal (even though the NCP specifically contemplates the use of "actions or controls . . . to manage the risk posed by treatment residuals or untreated wastes"). In fact, all three consultants contacted by the Company concluded that a properly designed permanent engineered shoreline could be an appropriate remedy for the Site. *See*, e.g., Anchor Report, at ES-8. ("[A permanent engineered shoreline] could be successfully implemented [at the Site],

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[12] The ROD analysis relies on unsupported conclusory statements that a CDF would not follow the shoreline or meet public interest standards, and therefore cannot be permitted by WDNR. However, the ROD does not explain why a CDF would not meet the public interest standards set forth in the Section 30.12 of the Wisconsin Statutes, or otherwise explain why a CDF would fail to comply with applicable ARARs. While the ROD hints at possible compliance issues with respect to Chapters 30 and 289 of the Wisconsin Statutes (governing WDNR Permits In Navigable Waters, and WDNR Landfill Siting And Approval Processes, respectively), the ROD does not include any detailed analysis or specific reasons why the agency believes there is a possibility of noncompliance.

[13] WDNR has argued that its authority to issue permits under Wis. Stat. Section 30.12 applies only to deposits of small amounts of incidental fill associated with other structures; however, Section 30.12 does not expressly limit WDNR's authority to permit a CDF, nor does it specify any maximum volume or amount of fill or deposit that may be authorized by permit. While Chapter NR 310 of the Wisconsin Code sets forth additional standards WDNR must consider when issuing an individual permit to construct a CDF, nothing in that chapter sets any specific limitation on the volume or amount of fill that may be authorized under Section 30.12, or authorizes WDNR to categorically refuse to issue an individual permit for a CDF simply because the proposed volume of material exceeds a certain threshold.

thereby meeting remedial goals in a technically sound and potentially cost- and time-effective manner . . . .”).

Moreover, this option “could be designed for the Site in a way that is safe[], cost effective, and in full compliance with environmental protection and site restoration goals while simultaneously supporting local community redevelopment opportunities.” *Id.*, at 51. For example, a permanent engineered shoreline could be designed to complement the City of Ashland’s redevelopment goals, as set forth in its Waterfront Development Plan, by:

- constructing all or part of the outer perimeter as a bulkhead wall that could accommodate access and docking by vessels and public boats, and/or incorporating a boat ramp;

- extending the grounds of Kreher Park outward over the surface of the permanent engineered shoreline as an enhanced public space, with options to include festival grounds, walking paths, native plantings, and a shoreline promenade to improve public access to the Chequamegon Bay shoreline;

- using the additional land area gained by a permanent engineered shoreline to house a community, education, or recreation center;

- designing the permanent engineered shoreline with part of the surface built to a lower elevation, to allow inundation by lake water and provide nearshore habitat area and function; or

- otherwise fashioning the permanent engineered shoreline to represent a public example of an environmentally sensitive remedial planning, consistent with the Site’s historic legacy and the recent refurbishment of the nearby treatment plant buildings and dock. Anchor Report, at 51; *see also* Attachment 2-D (providing graphic examples of potential enhancements that could be added to a permanent engineered shoreline to complement existing waterfront development plans).

Because a properly designed permanently engineered shoreline is legally permissible, complies with NCP criteria, and avoids the significant safety and environmental concerns associated with the dry dredge, NSPW is willing to consider implementing a reasonable engineered shoreline remedy in lieu of the dry dredge.

Fig. 6. Comparative Analysis of Dry Dredging and Alternative Remedies

| Superfund Evaluation Criteria | Dry Dredge | Wet Dredge with nationally recognized performance standards | Enhanced CDF |
|---|---|---|---|
| **Protective of Human Health and the Environment** | NO<br>Poses significant short-term safety and environmental risks that diminish overall protectiveness | Yes | Yes |
| **Compliance With Other Applicable Laws** | Yes | Yes | Yes |
| **Maximize Long-Term Effectiveness/Minimize RISKS** | NO<br>Failure mechanisms are anticipated | Yes<br>Highly Effective and Proven under site-specific circumstances | Yes<br>Highly Effective and Proven under site-specific circumstances |
| **Meets Performance Standards** | NO<br>Unlikely to be implementable | Yes | Yes |
| **Maximize Short-Term Effectiveness/ Minimize RISKS** | NO<br>poses increased short-term risks to human health and the environment that are more severe than alternative remedies, including worker safety and exposure to airborne hazards and nuisance to the community | Yes | Yes |
| **Implementability** | NO<br>Extremely Difficult to Implement; no consultant has recommended | Yes<br>Highly Implementable | Yes<br>Highly Implementable |
| **Cost Effective** | NO<br>Highest cost remedy | High cost remedy | YES<br>Lowest cost remedy |
| **Public Acceptance** | NO<br>Public does not support an unsafe remedy | Yes<br>Public supports a safe and effective remedy | Yes<br>Public supports a safe and effective remedy and CDF offers additional benefits for marina redevelopment |

In sum, due to the potential for catastrophic failure, the dry dredge is inferior to other alternatives with respect to nearly all prongs of the comparative analysis, and the ROD analysis failed to consider several important factors that weigh against the dry dredge, including without limitation (1) increased short-term exposure to workers and the community, (2) increased construction duration, (3) increased difficulty of implementation, (4) increased media requiring treatment, due to the generation of millions of gallons of contaminated lake water that will need to be stored and treated, (5) increased potential for long-term failure due to the potential for basal heave and mobilization of an otherwise stable NAPL plume, (7) the lack of increased in overall protectiveness or long-term effectiveness, and (8) the increased cost of performing the remedy without any concomitant increase in protectiveness.  Accordingly, the ROD does not set forth a reasonable basis for selecting the dry dredge, and its selection should be reconsidered in favor of an alternative remedy that complies with the NCP criteria, including without limitation, a wet dredge with appropriate performance standards or a permanent engineered shoreline.

## IV. CONCLUSION

For the foregoing reasons, NSPW respectfully requests that EPA accept the company's cash-out proposal, or allow the company to implement a reasonable, safe, and environmentally and economically sound remedy.

# ATTACHMENT 2-A

REPORT

# INDEPENDENT EVALUATION OF SEDIMENT REMOVAL ALTERNATIVES ASHLAND/NORTHERN STATES POWER LAKEFRONT SUPERFUND SITE

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**October 2012**

# INDEPENDENT EVALUATION OF SEDIMENT REMOVAL ALTERNATIVES

# ASHLAND/NORTHERN STATES POWER LAKEFRONT SUPERFUND SITE

**Prepared for**

Northern States Power – Wisconsin

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Anchor QEA, LLC


| | | |
|---|---|---|
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| Anchor QEA, L.P. | Anchor QEA, L.P. | Anchor QEA, L.P. |


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## LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| µg | microgram |
| ASCE | American Society of Civil Engineers |
| cm | centimeter |
| CDF | confined disposal facility |
| ft | foot |
| Foth | Foth Infrastructure and Engineering, LLC |
| FS | Feasibility Study |
| g | gram |
| $in^3$ | cubic inch |
| MSL | mean sea level |
| N/A | not applicable |
| DNAPL | dense nonaqueous phase liquid |
| NSPW | Northern States Power Company, a Wisconsin corporation |
| OC | organic content |
| pcf | pound per cubic foot |
| ppm | part per million |
| psf | pound per square foot |
| RAL | Remedial Action Level |
| RI | Remedial Investigation |
| ROD | Record of Decision |
| sec | second |
| SIR | Sediment Investigation Report |
| Site | Ashland/Northern States Power Lakefront Superfund Site |
| tPAH | total polycyclic aromatic hydrocarbon |
| USACE | U.S. Army Corp of Engineers |
| USEPA | U.S. Environmental Protection Agency |
| Weston | Weston Solutions, Inc. |
| Weston Report | Technical Memorandum regarding Conceptual Geochemical Assessment for Sediment Removal (Weston 2009) |
| WDNR | Wisconsin Department of Natural Resources |

# EXECUTIVE SUMMARY

Contaminated sediment sites are inherently complex. They require a detailed evaluation of unique site conditions and sediment cleanup options in order to optimize the effectiveness of the remediation effort as well as define associated costs, implementation realities, and risk reduction. Lessons learned from the design and construction should be integrated into the decision-making process as recommended by the U.S. Environmental Protection Agency's (USEPA's) *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites* (2005).

Sediment remediation at the Ashland/Northern States Power Lakefront Superfund Site (Site) on Lake Superior in Ashland, Wisconsin, is a significantly complex undertaking and therefore requires the application of such a decision-making process to arrive at a safe implementable, cost-effective cleanup approach that has a high probability of success. To this end, this independent evaluation discusses the assessment of alternative methods considered for sediment cleanup at the Site. This evaluation focuses largely on the "dry excavation" cleanup approach identified in the USEPA's Record of Decision (ROD) published in 2010 but also considers alternative cleanup approaches (e.g., "wet dredging" with environmental controls or a confined disposal facility [CDF]) that should be considered as a final cleanup plan is developed.

For sediments located along the shoreline of Chequamegon Bay in Lake Superior, the ROD requires "dry excavation of all nearshore sediment and wood debris and dredging of the remaining contaminated sediment and wood debris that exceeds the stipulated Remedial Action Level (RAL) for sediments" (USEPA 2010). The ROD also includes a provision for an alternate sediment remedy, in which wet dredging is potentially used, but the ROD includes the unusual provision that such an approach be strictly subjected to a "pre-design pilot test" in which the remedial work must meet a series of highly stringent performance standards.

Dry excavation, as conceptualized for the Site, would entail constructing an impervious barrier around the area to be excavated, removing water within the enclosed area, and then excavating dewatered sediments in the dry. This approach differs greatly from the more typically used process of wet dredging, where sediments are removed in their submerged state using excavation or pumping equipment that is extended down through the water. In fact, a Feasibility Study (FS) for the proposed project was completed by URS Corporation in 2008 concludes that dry excavation would present "potentially greater risk to human health, because of the need to work behind barriers engineered to keep out the waters of Lake Superior," while wet dredging "would provide the most long-term benefit at the least cost and with the fewest short-term technical implementation issues."

In 2009, Weston Solutions, Inc. (Weston), prepared a technical memorandum for the USEPA entitled "Conceptual Geotechnical Assessment for Sediment Removal" (referred to herein as the Weston Report) to assess sediment remediation at the Site. That document, unlike the FS prepared by URS in 2008, concludes that dry excavation could be a feasible means of removing contaminated sediments from the nearshore area of the Site. In retrospect, Weston's conclusions appear to have been a key element in the USEPA's inclusion of such a remedy in the ROD, although the concept of subdividing the dry excavation area into numerous smaller excavation enclosures is not anticipated nor evaluated in either the FS or the ROD.

In 2009, prior to the Weston Report being prepared for the USEPA, Foth Infrastructure and Engineering, LLC (Foth) conducted a bottom upheaval analysis of the dry excavation concept at the Site (the Weston Report was not made public until after the ROD was published). Foth draws different and independent conclusions in its 2009 memorandum, stating that elevated artesian pressures beneath the excavation area could result in instability and failure of the dry excavation system.

Recognizing the importance of artesian pressures on project success, Anchor QEA, LLC has conducted its own independent review of the available information and concludes that the dry excavation at the Site cannot be successfully accomplished with adequate safety and stability. Anchor QEA's conclusions are consistent with those presented by Foth in its 2009 memorandum; namely, that the consequences of dry excavation failure at the Site are numerous and serious in nature, ranging from construction difficulties to irreparable environmental damage and possible loss of human life. The most likely forms of dry excavation failure area—bottom upheaval, wall collapse, fracturing of the aquitard, and release of pressurized water into the excavation—all have significant potential to result in the above-mentioned consequences. The sediment remedy envisioned by the ROD does not appear to be an implementable solution and presents a significant risk to worker safety and construction success. These risks can be mitigated by using alternative sediment remedies that would meet overall site cleanup objectives.

## Summary of Independent Evaluation

Anchor QEA conducted a detailed review of the available information, including the Weston Report prepared for the USEPA and site field and laboratory data available to Weston in 2009. Many calculations conducted by Weston have been independently performed by Anchor QEA using refined and revised assumptions, where appropriate, and are summarized in Appendix A.

This independent evaluation documents Anchor QEA's findings and conclusions regarding various potential failure mechanisms applicable to the Site, as were analyzed and are presented in the Weston Report.

Anchor QEA evaluated four elements of Weston's work in regard to the dry excavation system:

- Assumed site characteristics used as the basis for Weston's analyses
- Bottom instability analysis
- Piping analysis
- Sheetpile design analysis

Anchor QEA concludes that many of the assumptions, procedures, and conclusions presented by Weston were insufficient to represent the known potential for variability of key site factors. Little consideration for the potential and associated consequences of a design failure was presented in the Weston Report. Anchor QEA's independent evaluation leads to design conclusions that reject the adequacy of the dry excavation system for the Site and concludes the approach is inadequate from an engineering design standpoint and unimplementable in the field without severe risk to environmental conditions and to human safety.

In summary, Anchor QEA's independent evaluation presents the following conclusions:

- The generalized soil profile developed by Weston and used as the basis of its assessments does not adequately represent the possible range of conditions that have been identified by field work. The wide range of known conditions at the Site increases the uncertainty of the analyses and justifies using higher factors of safety during design elements.

- An unorthodox method was used by Weston to assess the potential for bottom upheaval (the result of upward hydrostatic pressures exceeding the weight of bottom sediments). This method was used to erroneously conclude that there is sufficient stability, while in Anchor QEA's opinion there is not.
- A dry excavation system using segments formed by individual 150-foot by 200-foot excavation "cells" was envisioned by Weston. This concept is inconsistent with the approach described and evaluated in the FS and the ROD. With a segmental excavation approach, much smaller excavation cells would be necessary and furthermore these smaller cells may potentially be inadequate to address the significant safety issues associated with dry excavation, may exacerbate site conditions, and would be cost ineffective.
- Weston's concept of subdividing the dry excavation area into separate cells is an attempt to propose an engineering solution that mitigates some challenges and uncertainties associated with dry excavation. However, it appears unlikely that this approach could maintain a stable excavation, as its application would be subject to a great number of field variables, analytical uncertainties, and risk. Furthermore, the separate excavation cell approach was not contemplated by the USEPA in the ROD. It is Anchor QEA's opinion that there are too many variables that can never be completely quantified with sufficient precision to safely design and implement the dry excavation system.
- The evaluation of the sheetpile wall design indicates that any sheetpile barriers installed for the project may need to extend fully through the aquitard and into the underlying aquifer, which could permanently compromise the aquitard.

The likely forms of dry excavation failure—bottom upheaval, wall collapse, fracturing of the aquitard, and release of pressurized water into the excavation area—would all lead to irreversible damage and environmental degradation that far exceeds what is currently documented at the Site. As demonstrated in this evaluation, implementation of Weston's proposed solution will be very costly and is likely to create new environment problems that would exacerbate site environmental conditions in an irreparable manner. Therefore, Anchor QEA envisions a dry excavation system as being undesignable within the standards of professional care and engineering practice. In Anchor QEA's opinion, the unique conditions and challenges of the Site render it an extremely poor candidate for dry excavation—especially when far simpler and far better demonstrated methods are available as an alternative, including wet dredging or implementation of a CDF. Wet dredging is a safer and more environmentally sound approach that can be applied to sediment remediation at the Site. Other options such as an enhanced CDF design should also be considered to accomplish mass sediment removal.

Table ES-1 summarizes the key design assumptions made in the Weston Report, which Anchor QEA has determined to be of concern and/or unsupportable.

**Table ES-1**
**Summary of Anchor QEA's Independent Evaluation**

| Key Elements | Key Assumptions by Weston | Issues/Concerns with Weston's Assumptions | Anchor QEA's Assumptions |
|---|---|---|---|
| Soil Profile (discussed in Section 2) | • Lake Water Depth = 8.5 feet<br>• 28-foot Aquitard Layer (8 feet of Clay, 20 feet of Silt)<br>• Sediment Removal Depth = 5 feet | • Weston's assumed soil profile is not representative of soil conditions at all locations on site. This leads to false conclusions regarding the adequacy of dry excavation stability. Designing a dry excavation in unfavorable soil conditions that is based on favorable soil conditions can result in a catastrophic failure. | • Lake Water Depth = 13 feet<br>• 23-foot Aquitard (all Clay)<br>• Sediment Removal Depth = 8.5 feet |

| Key Elements | Key Assumptions by Weston | Issues/Concerns with Weston's Assumptions | Anchor QEA's Assumptions |
|---|---|---|---|
| Soil Properties (discussed in Section 2) | Soil shear strength:<br>• Clay – 660 psf<br>• Silt – 1250 psf<br><br>Soil unit weights:<br>• Clay – 124.5 pcf<br>• Silt – 130 pcf | Shear strengths were assumed to be based on a compressive failure mode. However, actual failure would occur in an extension and direct shear failure mode, which soils are weaker at resisting.<br><br>Assumed soil unit weights appear to be excessively high, which overestimates the resistance to hydrostatic uplift forces.<br><br>Both effects result in Weston's overlooking likely failure conditions. | Used lower soil shear strength:<br>• Clay – 460 psf<br><br>Used lower soil unit weights:<br>• Clay – 110 pcf<br>• Silt – 120 pcf |
| Bottom Upheaval (discussed in Section 3) | Modified standard formula to include additional resistance of soil to uplift conditions<br><br>Assumed bottom soils would undergo uplift as a rectangular mass<br><br>Envisioned subdivision of dry excavation into individual segments, a concept not mentioned nor explored in the FS and ROD<br><br>Targeted a minimum factor of safety of 1.25 | Published and peer-reviewed design formulas were altered based on Weston's unsupported presumptions regarding soil mass resistance to uplift.<br><br>Assuming the uplift failure occurs as a monolithic rectangular mass is an unrealistic expectation of soil behavior.<br><br>The targeted factor of safety applies to standard design formula use. Because of uncertainty with soil conditions, and the critical nature of the system (i.e., potential loss of life), a higher factor of safety should be targeted. | Used standard unmodified design formula, as originally intended<br><br>Used more appropriate soil profile and silt and clay properties (described above)<br><br>Targeted a minimum factor of safety of 1.5 |

| Key Elements | Key Assumptions by Weston | Issues/Concerns with Weston's Assumptions | Anchor QEA's Assumptions |
|---|---|---|---|
| Shear Instability (discussed in Section 3) | Modified standard design approach by incorporating artesian pressures as upward-acting "surcharge" loads.<br><br>Targeted a minimum factor of safety of 1.25 | Published, peer-reviewed design guidance was altered in a manner that is not supported by engineering literature.<br><br>The targeted factor of safety applies to standard design formula use. Because of uncertainty with soil conditions, and the critical nature of the system (i.e., potential loss of life), a higher factor of safety should be targeted. | Used design methodology that is supported by engineering literature.<br><br>Used more appropriate soil profile and silt and clay properties (described above)<br><br>Targeted a minimum factor of safety of 1.5 |
| Piping (discussed in Section 4) | Aquitard is assumed to be intact and homogeneous (ignored disturbance from sheet pile installation) | Aquitard soils may contain naturally occurring fractures and irregularities through which water can propagate.<br><br>Sheet pile installation into and through the aquitard will create a zone of damage through which artesian pressure and groundwater can be released.<br><br>Piping, which can undermine foundation soils, was not evaluated. | Piping appears to be a likely occurrence given conditions at the Site |
| Sheetpile Embedment (discussed in Section 5) | Did not account for wind, waves, and ice loading on the wall(s).<br><br>Minimum sheetpile embedment of 27.4 feet<br><br>Targeted a minimum factor of safety of 1.3 | Wind, wave, and ice loading are likely to be significant forces and cannot be overlooked in the wall stability analysis.<br><br>Sheetpile embedment through the aquitard and into the confined aquifer will lead to piping and release of groundwater into the excavation.<br><br>A factor of safety of 1.3 to 1.5 is typical for temporary earth retaining structures. 1.5 is relevant for conceptual design where information gaps exist. | Used more appropriate soil profile and silt and clay properties (described above)<br><br>Reevaluated embedment depth with a factor of safety of 1.5 to account for the negligence of wind, waves, and ice.<br><br>Sheetpiles will need to extend well into the confined aquifer layer. |

## Evaluation of Alternative Sediment Remedies

Anchor QEA evaluated other possible alternatives for sediment remediation at the Site as a result of the inherent problems encountered during the independent evaluation of the dry excavation system. The ROD itself includes a provision for a more typical wet dredging approach, which in Anchor QEA's experience and opinion is a sound remedial concept for the Site. However, the ROD obscures the viability of the wet dredging remedy by linking it to what could be interpreted as onerous requirements and performance standards, including the requirement to perform a pre-design pilot test, such that an otherwise solid concept becomes highly inefficient, time-consuming, and costly as presented in the ROD. In this independent evaluation, Anchor QEA presents opinions regarding simple modifications to the wet dredging approach that would make it far more effective and time-efficient without sacrificing any of the USEPA's environmental protection goals.

Anchor QEA evaluated another concept for sediment remediation at the Site: placement of sediments within a stabilized nearshore CDF, which would permanently remove contaminated sediments from the environment while also providing numerous opportunities for shoreline enhancement and public use (as is detailed in Section 6.2). Anchor QEA's review leads to the conclusion that a CDF could be successfully implemented, thereby meeting remedial goals in a technically sound and potentially cost- and time-effective manner as well as presenting a unique opportunity to integrate site improvements and concepts for community redevelopment. A CDF affords a diverse set of options for design and construction and could be amplified with prospective features related to environmental benefits, public use and access, and habitat value, which are all consistent with the City of Ashland's waterfront redevelopment goals.

## Qualifications of Anchor QEA

Anchor QEA, the firm that prepared this report, is an environmental and engineering consulting company that specializes in projects with aquatic, shoreline, and water resource components. Appendix B presents an overview of the firm's history and expertise, along with resumes for the three individuals who led the evaluation described in this report (David Templeton, Michael Whelan, P.E., and John Verduin, P.E.).

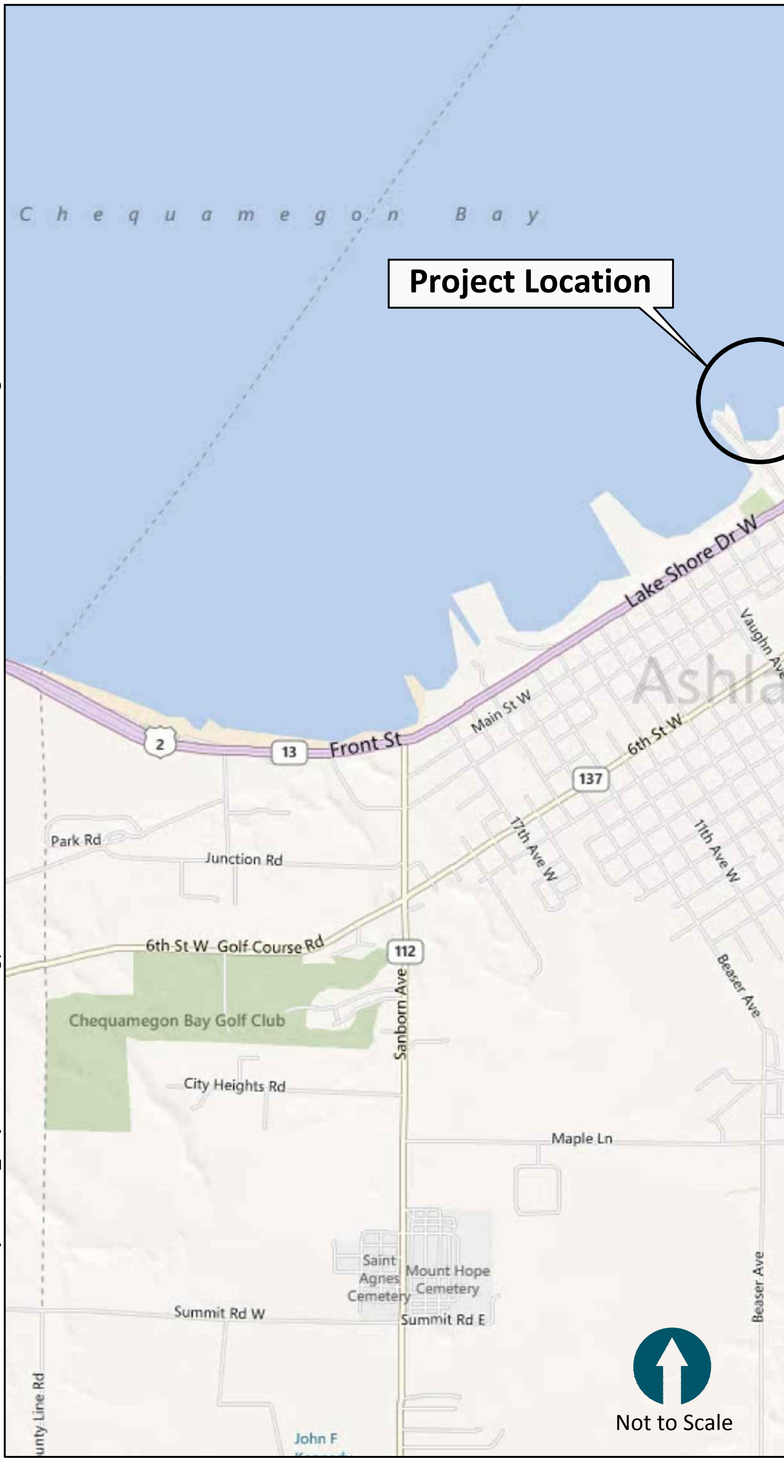
# 1 INTRODUCTION

This report presents an independent evaluation of alternative sediment removal and remediation strategies envisioned for sediment cleanup at the Ashland/Northern States Power Lakefront Superfund Site (Site) in Ashland, Wisconsin (Figure 1). In particular, this report focuses on the "dry excavation" method and work completed by others to evaluate its likelihood of success. This report addresses the potential adequacy and implementability of other remedial strategies, including "wet dredging" and the use of a nearshore confined disposal facility (CDF).

## 1.1 Record of Decision History

In September 2010, the U.S. Environmental Protection Agency (USEPA) published a Record of Decision (ROD) documenting the mandated cleanup of chemically impacted soils, groundwater, and sediments at the Site. For sediments located along the shoreline of Chequamegon Bay in Lake Superior, the ROD requires "dry excavation of all nearshore sediment and wood debris and dredging of the remaining contaminated sediment and wood debris that exceeds the Remedial Action Level (RAL)." The ROD defines the Remedial Action Level (RAL) for total polycyclic aromatic hydrocarbons (tPAH) as 2,295 micrograms per gram of organic content (μg/g OC; equivalent to 9.5 parts per million [ppm] tPAH at 0.415 percent). The ROD also includes a provision for an alternate sediment remedy, in which wet dredging is potentially used but is strictly subject to a pre-design pilot test for which highly stringent performance standards are established. The pilot test, as envisioned by the ROD, would be a pre-design requirement conducted prior to finalizing the dredging design and therefore would likely require a separate field mobilization from the actual remedial action itself.

In 2009, Weston Solutions, Inc. (Weston), prepared a technical memorandum entitled "Conceptual Geotechnical Assessment for Sediment Removal" (referred to herein as the Weston Report) to asses sediment remediation at the Site, though the report was not provided to the responsible parties nor the public until a year later after the ROD was published. That document, unlike the FS, concludes that dry excavation could be a feasible means of removing contaminated sediments from the nearshore area of the Site.





**SOURCE**: Drawing prepared from Bing Road Maps.

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Oct 11, 2012 2:05pm mpratschner

ANCHOR QEA

**Figure 1**
Vicinity Map
Ashland/NSPW Lakefront Superfund Site

Weston's conclusions appear to have been a key element in the USEPA's inclusion of such a remedy in the ROD, although its concept of subdividing the dry excavation area into numerous smaller excavation enclosures is not anticipated nor evaluated in either the FS or the ROD.

Anchor QEA, LLC conducted a detailed review of the Weston Report and site field and laboratory data available to Weston in 2009. Many calculations conducted by Weston were independently performed by Anchor QEA using refined and revised assumptions, where appropriate. This independent evaluation documents Anchor QEA's findings and conclusions regarding the various potential failure mechanisms applicable to the Site, as they were analyzed and presented in the Weston Report.

## 1.2 Summary of Conclusions Described in Record of Decision

Dry excavation is a construction technique that in a lakefront or offshore setting involves installing a wall or cutoff structure capable of retaining the surrounding water to create an enclosed area from which water can be pumped out, leaving the previously submerged subgrade exposed and available for excavation using land-based, earth moving equipment and methods. Dry excavation is a conceptual alternative to the more frequently used method of wet dredging, where material is removed in its submerged state using water-borne equipment, such as a digging bucket or hydraulic pump. While the ROD contains a provision for potentially using wet dredging techniques to remove nearshore wood waste and sediments, this remedy is subject to the unusual requirement of a pre-design pilot test, which must satisfy unique and stringent performance standards as interpreted by the USEPA and the Wisconsin Department of Natural Resources (WDNR).

Because the ROD mandates dry excavation as the primary selected remedy for site sediments, Northern States Power Company, a Wisconsin corporation [NSPW], through its consultants, evaluated the means by which such a remedy could be designed and implemented. Such an evaluation builds on the FS that assessed both wet dredging (SED-4) and dry excavation (SED-5 and SED-6) alternatives. The FS concluded that dry excavation (SED-5 and SED-6) would present "potentially greater risk to human health, because of the need to work behind barriers engineered to keep out the waters of Lake Superior," while wet dredging (SED-4) "would provide the most long-term benefit at the least cost and with the fewest short-term technical implementation issues" (URS 2008). It was after completion of the FS that Foth identified potential catastrophic risks associated with the dry excavation remedy, including the potential for basal heave. Those concerns were included in comments submitted by NSPW in response to the ROD (Xcel Energy 2009).

Regardless of the conclusion of the FS, the ROD mandated the SED-6 alternative (dry excavation of nearshore wood waste and sediments with dredging used for materials further offshore) as the primary method of sediment cleanup. The USEPA's rationale for the selection of this method is primarily based on the supposition that wet dredging could release a significant and unacceptable amount of free product into the water column and environment. In an attempt to further support this decision, the USEPA also stated its expectation that dry excavation would make it "possible to see what is being removed without the need to control for the release of free product" (USEPA 2010). The ROD states:

> The dry excavation of sediments in Alternatives SED-5 and SED-6 are the best methods to quickly remove COCs [contaminants of concern] and achieve protection, but there are increased concerns with worker safety in a dry excavation scenario, but [sic] dry excavation is a commonly used technology and there are effective and reliable mitigation measures that will be developed during the design phase for the remedial action.

Neither the FS nor the ROD discusses another significant factor likely to influence the reliability of dry excavation at the Site: the presence of artesian hydrostatic pressures within the aquifer below the excavation area. This factor was subjected to a preliminary geotechnical evaluation and is discussed by Foth in its 2009 memorandum. Foth suggests that the elevated artesian pressures could result in basal heave failure, in which underlying porewater pressures exceed the overlying soil weight after excavation; potentially resulting in significant risks to project stability and safety (Foth 2009).

The consequence of excavation failure are numerous and range from construction problems, to irrevocable environmental damages, to potential loss of human life. The most significant consequence is also the most imminent, which is the threat of series injury or death associated with the instant flooding that would occur, should an excavation side wall fail. In addition, considerations must be made for the significant and irreparable environmental risk associated with a potential failure of the retaining structure that would be needed for the dry excavation concept. Two modes for exacerbated environmental contamination could results from excavation failure:

- Rupture or failure of an excavation side wall would very quickly flood the excavation area, resulting in the release of free product into Lake Superior and thus the resuspension and redistribution of contaminated sediments over a much wider area than that being remediated.
- An upheaval failure of the excavation bottom would result in escape of underlying artesian aquifer water that would induce migration of the upland dense nonaqueous phase liquid (DNAPL) plume.

Both of these environmental risks would cause irreparable environmental harm. Neither of these pathways for significant environmental risks would be present for a wet dredging remedy. Another potential effect of failure would be the breaching of the aquitard, such that the confined groundwater would now discharge at the Site instead of further offshore. This early discharge could potentially impact groundwater levels in the upland areas potentially affecting wells.

## 1.3 Use of Factor of Safety in Documenting Engineering Conclusions

The engineering profession uses the concept of "factor of safety" to estimate if a design (of a bridge, dam, structure, etc.) is adequately stable for the use and design life for which it was intended. The term factor of safety is mentioned on numerous occasions in this report, as it was in the Weston Report, and is applied to a number of different types of geotechnical analyses. The principal of applying a factor of safety for design purposes is the same as those applied in numerous facets of everyday life, under a wide range of circumstances, ranging from managing simple inconveniences by arriving extra early at an airport to catch a flight, to improving personal safety by ensuring that one's tires have sufficient remaining tread and that snow chains are on hand for wintertime driving, The essential point is that in order to avoid problems and manage risk in critical situations, it is necessary to add an extra amount of safety or caution so that unknown variables or unforeseen circumstances do not trigger severe danger or calamity.

The numeric definition of a factor of safety is the ratio between the forces that resist a failure and forces that cause failure. Theoretically, a factor of safety below 1 means a design is unstable (i.e., driving forces exceed the resisting forces), while a value of exactly 1.0 implies that all forces are balanced. The development of a design requires calculating or estimating site conditions, soil properties, and forces (as discussed in Section 2), which are all subject to some degree of uncertainty. Engineers typically account for this uncertainty by requiring that a design's factor of safety be greater than a minimum value. An engineer's selection of a factor of safety is based on uncertainties associated with the design and the consequences that would result from a failure. Consequences are weighted depending upon the nature of the damages that could occur if a failure mode occurs, with loss of life being considered a more serious consequence than loss of property.

## 1.4 Engineering Analyses Performed by Weston

In response to the Foth 2009 engineering conclusion, the USEPA commissioned Weston (after the close of the public comment period but prior to publication of the ROD in 2010) to conduct an independent geotechnical assessment of the stability of dry excavation if conducted at the Site. The objective of Weston's assessment, as its report states, was to "complete a more rigorous and thorough evaluation of not only basal heave but other failure mechanisms that could pose a potential risk to workers, the environment, and to the successful completion of the project." The Weston Report's conclusion, while appropriately qualified by the fact that its work was limited to only data available at the time, is that "the near-shore, bay bottom sediments likely can be safely removed using dry excavation techniques assuming that conceptual planning, final design engineering and implementation of the construction work are all properly executed" (Weston 2009). The Weston Report describes recommendations for additional data collection to support further design analyses and provides a lengthy set of calculations documenting its conclusions regarding the stability of a dry excavation conducted under assumed site conditions.

It would appear, in the absence of other published analyses on the topic (aside from Foth 2009), that Weston's engineering conclusions were sufficient to convince the USEPA that dry excavation was the most appropriate remedial alternative for the Site, even in light of the known artesian pressures underlying the excavation area. Due to the undeniable importance of this issue, and its potential to add significant risk to the project, an independent evaluation of Weston's analyses and conclusions was warranted and is the subject of this report.

## 1.5 Independent Engineering Evaluation by Anchor QEA

Anchor QEA conducted a detailed review of the Weston Report and site field and laboratory data available to Weston in 2009. Many calculations conducted by Weston were independently performed by Anchor QEA using refined and revised assumptions, where appropriate. These data include the information that was available to Weston (and Foth) in 2009 as well as more recently obtained information, most notably, the *Data Gap Investigation Report* prepared by Burns and McDonnell in 2011. This independent evaluation documents Anchor QEA's findings and conclusions regarding the various potential failure mechanisms applicable to the Site, as they were analyzed and presented in Weston Report.

The Weston Report presents five components of design analysis that together serve as the basis for its conclusion that dry excavation can safely and effectively be performed. These design considerations are:

1. Assumed soil and sediment profile underlying the excavation area and water levels and artesian pressures in the aquifer below (as detailed in Appendix A of the Weston Report)
2. Structural stability of sheetpile walls required to retain water from Lake Superior, allowing removal of standing water from the dry excavation area (Appendix B of the Weston Report)
3. Potential for upheaval of the bottom during dry excavation due to unbalanced soil weight and upward hydrostatic pressure (Appendix C of the Weston Report)
4. Potential for excavated subgrade "blowout" due to shear failure of base soils in response to upward hydrostatic pressures (Appendix D of the Weston Report)

5. Potential for piping (i.e., loss of interparticle strength) of subgrade soils due to upward hydraulic flow (Appendix E of the Weston Report)

Each design component was independently evaluated and analyzed by using available field and laboratory data. Anchor QEA's evaluation of these data and its variability resulted in many instances where overly optimistic engineering assumptions made by Weston were revised by Anchor QEA. These revisions were typically done to achieve a reasonably (but not overly) conservative design analysis that recognized the potential for variability in many crucial site parameters.

It is Anchor QEA's conclusion that many of the assumptions, procedures, and conclusions presented by Weston are insufficient to represent the known potential for variability of key site factors. In doing so, Weston has introduced a larger uncertainty into its analyses, which strongly impacts the design's factor of safety that ultimately protects human health and life. Weston's approach also creates potential for significant cost increases and exacerbation of site conditions. Anchor QEA's independent evaluation leads to design conclusions that are safer, more reasonable, more realistic, and more appropriate than the unnecessarily and unrealistically optimistic conclusions offered by Weston for the adequacy and implementability of the dry excavation remedy at the Site.

## 1.6 Evaluation of Alternative Remedial Approaches

The ROD includes a provision for a wet dredging remedy, along with multiple requirements and performance standards by which the success of the remedy would be measured. Significantly, the ROD requires that a wet dredging remedy be preceded by a pre-design pilot test to demonstrate that the method can be used to successfully meet remedial goals (USEPA 2010).

In Section 6.1 of this report, Anchor QEA presents opinions on the wet dredging remedy for the Site, including means by which it could be made more effective and time-efficient without sacrificing any of the USEPA's environmental protection goals.

Section 6.2 of this report provides a generalized overview of another concept for sediment remediation at the Site: the use of nearshore enhanced CDF to permanently remove contaminated sediments from the environment and meet remedial goals in a technically sound and potentially cost- and time-effective manner. A nearshore CDF would allow for a unique opportunity to not only optimize environmental protectiveness but could also be used enhance public access, usage, and recreation at the Site while promoting local community redevelopment efforts. Section 6.2 also presents further discussion of the ways that a nearshore CDF could be used to simultaneously meet remedial goals while also enhancing public use of this important and prominent lakefront property.

## 1.7 Report Structure

The remainder of this report is as follows:

- **Section 2 –** Assumptions and approaches Weston used to characterize the Site and Anchor QEA's independent evaluation of this characterization
- **Section 3 –** Assumptions and approaches Weston used to evaluate dry excavation bottom instability and Anchor QEA's independent evaluation of this analysis
- **Section 4 –** Assumptions and approaches Weston used to evaluate piping potential and Anchor QEA's independent evaluation of this analysis
- **Section 5 –** Assumptions and approaches Weston used to evaluate sheetpile design and Anchor QEA's independent evaluation of this analysis
- **Section 6 –** Discussion of potential alternative sediment remedial alternatives (wet dredging and CDF)
- **Section 7 –** Summary of Anchor QEA's independent evaluation, findings and opinions regarding implementability of dry excavation, and recommended project direction
- **Section 8 –** References used in this report

# 2 EVALUATION OF SITE CHARACTERIZATION

## 2.1 Summary

Any engineering evaluation of earthwork-related activities, such as excavation, dredging, or backfilling, requires as its basis a solid understanding of the geological conditions and material properties that exist at a site. Engineers obtain information on sediments, soils, water, and conditions at and below the current ground (or mudline) surface and use this information to develop estimates of engineering properties, such as material weight, thickness, and strength. When conditions vary significantly across a site, the engineering properties must be selected carefully to properly reflect this variability.

This section presents an evaluation of Weston's use of available site data to develop an assumed sequence of material types and thicknesses at the Site and presents an independently evaluated, and more representative, set of values for use in the calculations presented in subsequent sections.

## 2.2 Assumptions and Approach used by Weston

The Remedial Investigation and FS (RI/FS; URS 2007, 2008) and Sediment Investigation Report (SIR; SEH 1996) served as the primary sources of information for site characterization at the time Weston published its report. The SIR includes two offshore borings (29N/15E and 29N/20E), which provide the only geotechnical information for in-water site conditions at the time of the Weston Report. It is critical to note that these borings did not fully penetrate the aquitard (Miller Creek Formation). Two shallow in-water borings from the SIR (25N/15E and 25N/20E), while not geotechnical in nature, were used to estimate sediment surface elevation and thickness. Weston supplemented in-water explorations with test results and observations from three upland monitoring wells documented in the RI/FS (MW-24a, MW-25a, and MW-26), all of which are far removed from the specified sediment removal area and fully penetrated the aquitard.

Weston used the above-mentioned information to develop a singular soil profile, which served as the basis for its analyses. The resulting soil profile is presented on Figure 2, while Table 1 presents a summary of Weston's approach for developing assumptions for each component of the soil profile.

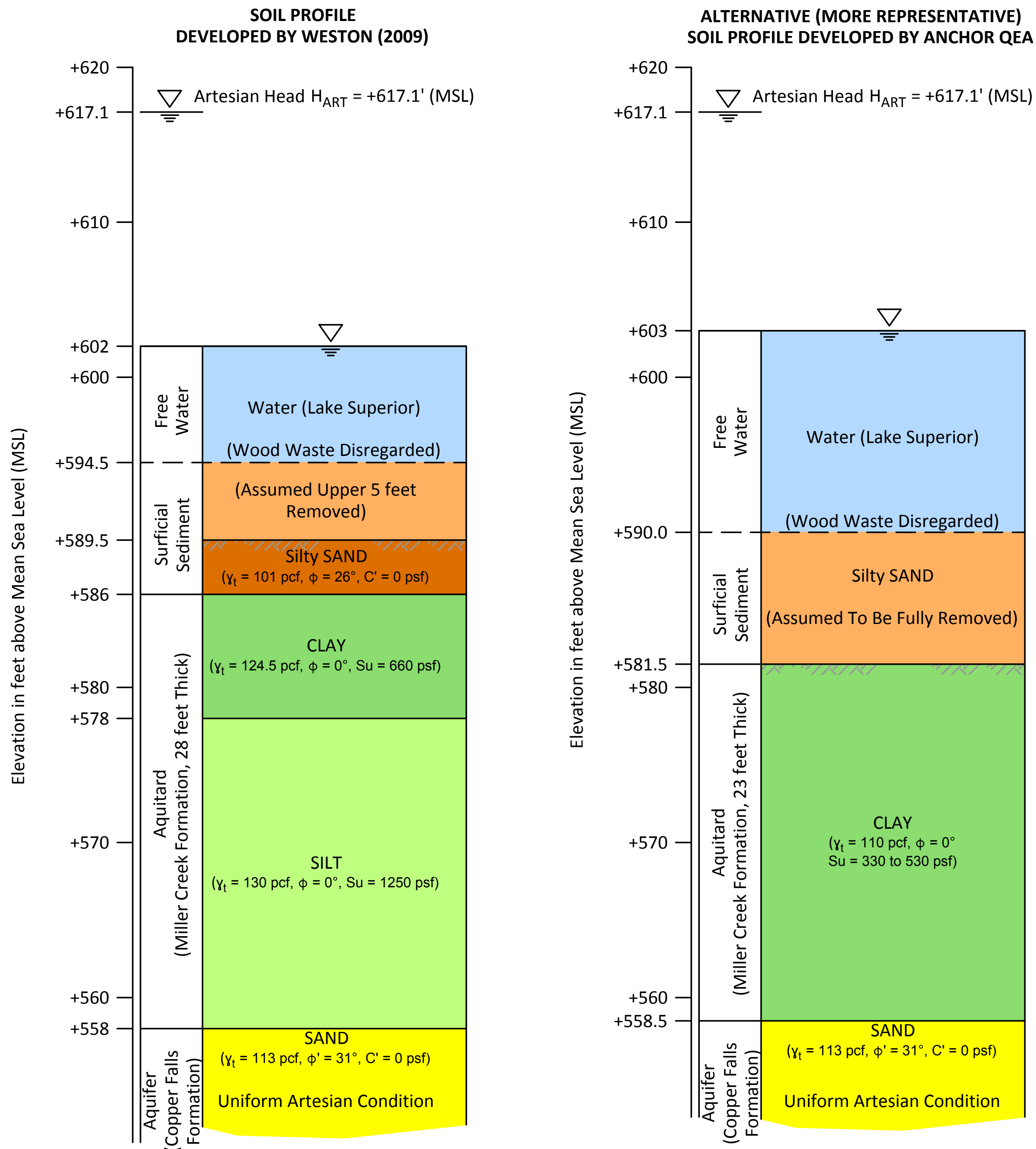





**Figure 2**
Comparison of Soil Profiles
Ashland/NSPW Lakefront Superfund Site

**Table 1**
**Summary of Soil Profile Developed by Weston**

| Element of Soil Profile | Weston's Approach | Assumption Made |
|---|---|---|
| Lake water elevation | Used values reported in SIR. | 602 feet |
| Wood waste elevation and thickness | The wood waste is intentionally disregarded in the soil profile, with the explanation that it provides little to no weight or resistance strength. | N/A |
| Top elevation of surficial sediment | Averaged value from two shallow in-water borings (25N/15E and 25N/20E). | 594.5 feet |
| Thickness of surficial sediment layer | Averaged value from two shallow in-water borings (25N/15E and 25N/20E). | 8.5 feet |
| Elevation of contact between surficial sediment and aquitard (Miller Creek Formation) | Calculated from in-water surface sediment elevation and thickness. | 586 feet |
| Thickness of aquitard | Averaged the two lowest values observed in the three upland monitoring wells (i.e., 23 feet and 32.5 feet were averaged, 41 feet was omitted). | 28 feet |
| Composition and unit weight of aquitard<br>(i.e., clay and silt component layers) | Used results from the in-water borings to determine the thickness of the clay layer. Calculated the thickness of silt from assumed aquitard thickness. | Clay – 8 feet<br>Silt – 20 feet |
| Dredge depth beneath wood waste | Value assumed by Weston (no supporting reference provided). | 5 feet |
| Artesian pressure in aquifer | Value reported by Foth (2009). | 617.1 feet |

Notes:
N/A = not applicable
1 All elevations are reported relative to mean sea level (MSL).

The engineering soil properties identified by Weston are derived using empirical correlations with uncorrected blow count values from in situ sampling. The respective blow count values for each soil unit were averaged to determine a representative blow count ($N_{REP}$), which served as the basis for deriving the engineering soil properties. Weston excluded unusually large blow count values in its estimate of $N_{REP}$.

Blow count correlations were used to derive the estimated unit weight and unconfined compressive strength for fine-grained soils (i.e., silt and clay) in the aquitard, and unit weight and friction angle for coarse-grained soils (i.e., sand) in the aquifer. The undrained shear strength value reported for clay was verified with pocket penetrometer test results performed on soil samples at the time of the field investigation. The estimate of permeability for soil layers was based on reportedly typical values for the general soil types, although no reference was provided. Table 2 summarizes the values Weston used in its analysis. No site-specific strength, permeability, or unit weight laboratory tests were completed—only blow count correlations, as previously described, were used.

**Table 2**

**Summary of Engineering Soil Properties Derived by Weston**

| Soil Unit | Representative Blow Count ($N_{REP}$; blows/ft) | Total Unit Weight (pcf) | Undrained Shear Strength (psf) | Internal Friction Angle (degrees) | Vertical Permeability (cm/sec) |
|---|---|---|---|---|---|
| Sediment | 6 | 101 | 0 | 26 | $1x10^{-2}$ |
| Clay layer of aquitard | 9 | 124.5 | 0[1] | 31[1] | $1x10^{-7}$ |
| Silt layer of aquitard | 17.5 | 130.5 | 660 | 0 | $1x10^{-5}$ |
| Sand (aquifer) | 13 | 113 | 1,250 | 0 | $1x10^{-3}$ |

Notes:
blows/ft = blows per foot
cm/sec = centimeters per second
pcf = pounds per cubic foot
psf = pounds per square foot
1 Weston uses 31 psf for undrained shear strength and 0 for internal friction angle. It appears likely that the reporting of these values was inadvertently transposed by Weston in its text, as the reverse was used for calculations in the appendices.

## 2.3 Evaluation of Assumptions and Approach

### *2.3.1 Soil Profile*

A soil profile and associated engineering soil properties representing a range of conditions, rather than a single "average" soil profile, is commonly used to evaluate the typical and most critical case and should be examined in the early stages of the design process. The assumptions and approach used by Weston in the development of its single average soil profile is not representative of all possible site conditions, which ultimately results in misleading conclusions for the feasibility of dry excavation. Weston's method for the soil profile does not account for risks associated with conditions in all areas of the Site.

Anchor QEA used existing site information to develop an alternative soil profile, which differs from that developed by Weston (summarized in Table 1) in some important aspects. The Anchor QEA soil profile, presented alongside Weston's profile on Figure 2, better represents the expected range of parameters that apply at the Site and shows less favorable conditions for dry excavation than shown in Weston's profile. When evaluating dry excavation design conditions, realistic parameters must be used as worker safety and environmental protection is dependent on wall stability. Each key parameter is discussed below and compared between the Weston and Anchor QEA soil profiles.

***Lake Water Elevation.*** Weston assumed a water elevation of 602 feet, which is based on information taken from the SIR. In the RI/FS, URS reports that lake water elevations range from 601 to 603 feet (URS 2007, 2008). Because the project duration is expected to continue for several years, Anchor QEA believes a surface water elevation of 603 feet should be used.

***Wood Waste Elevation and Thickness.*** Weston intentionally disregards the wood waste in its analysis. The engineering soil properties of the wood waste would be difficult to estimate effectively and neglecting its presence is slightly conservative, because the material would be a small contributor to any stabilization should any remain in place after the excavation. Therefore, neglecting the presence of the wood waste is an appropriate and moderately conservative assumption for this analysis; the effect of the wood waste on the design is negligible.

***Top Elevation of Surficial Sediment.*** While Weston assumes a sediment surface elevation of 594.5 feet, an elevation as deep as 590 feet is implied by Figures 3-3 to 3-6 from the FS and the SIR cross sections (URS 2008; SEH 1996). The deeper sediment surface elevation would mean deeper water and, therefore, a higher hydrostatic force on the wall. In Anchor QEA's opinion, the wall system should be evaluated using an elevation of 590 feet as the surface elevation for the in-water sediments.

***Thickness of Surficial Sediment Layer.*** The general range of sediment thicknesses observed in the SIR cross sections across the excavation area is 5 to 8.5 feet (SEH 1996). Weston averages the thicknesses observed from 25N/15E (8 feet) and 25N/20E (9 feet) to obtain a sediment thickness of 8.5 feet. Therefore, Anchor QEA agrees that 8.5 feet is a reasonable estimate for sediment thickness.

***Elevation of Contact between Sediment and Aquitard.*** Weston uses an elevation value of 586 feet, calculated by subtracting the sediment thickness from the sediment surface elevation. Using this same approach with values of 8.5 and 590 feet (for the sediment thickness and sediment surface elevation, respectively), a contact elevation of 581.5 feet is calculated.

***Thickness of Aquitard.*** The in-water borings from the SIR used by Weston did not fully penetrate the aquitard and, therefore, are not useful for determining this element of the soil profile. Three upland monitoring well logs (MW-24a, MW-25a, and MW-26) from the RI/FS fully penetrate into the aquifer and were selected by Weston to determine the aquitard thickness. Weston neglects the highest value of 41 feet and averaged the values of 23 and 32.5 feet, rounding the result to 28 feet.

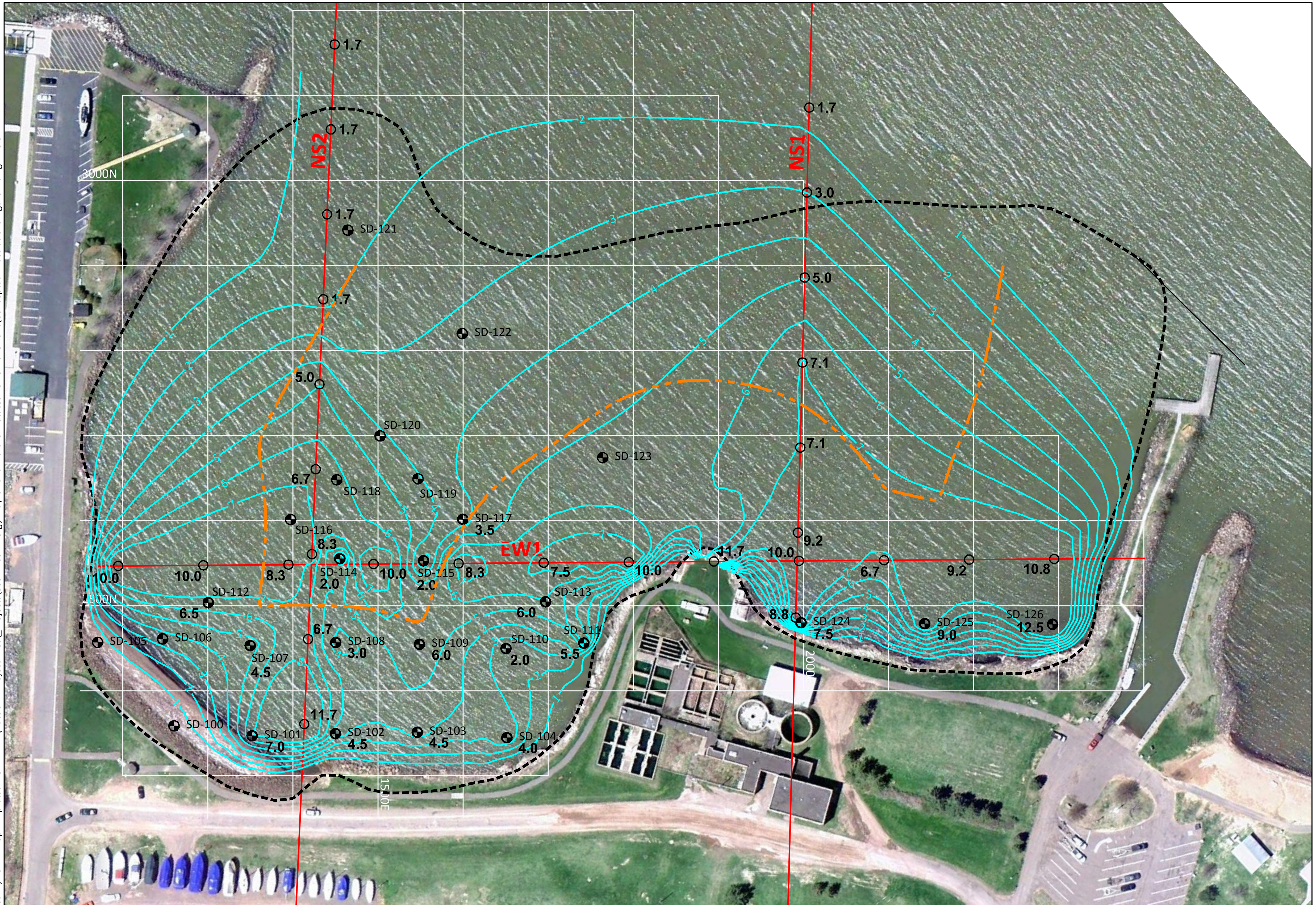
By averaging the two lowest thicknesses, the full known variability of the aquitard thickness is not represented. A more appropriate selection would be to evaluate the range of thicknesses including the lowermost value of 23 feet, because the bottom instability analysis is highly dependent on the thickness of the aquitard. In fact, logs for other monitoring wells completed upland document the thickness of the aquitard to be as low as 7 feet, which further demonstrates the high degree of variability of the aquitard thickness across the Site. By failing to account for thinner areas of aquitard, Weston's analyses significantly underestimate the risks at those locations.

***Composition and Unit Weight of Aquitard.*** Weston's assumption for the composition of the aquitard is based on two deeper in-water borings, 29N15E and 29N20E. These borings penetrated 9.5 and 8 feet, respectively, into the aquitard. Boring 29N15E revealed 7.5 feet of clay overlying a silt deposit, while boring 29N20E encountered 8 feet of clay with no silt deposit observed. Weston assumed that the aquitard is comprised of an 8-foot-thick clay layer overlying siltier materials 20 feet in thickness, comprising the assumed 28-foot-thick aquitard.

Weston's assumption that the aquitard includes a 20-foot-thick silt layer is critical because of the silt layer's assumed higher strength and unit weight than the clay. Weston terminates its assumed clay layer at 8 feet even though only one of the two borings fully penetrated the clay. Furthermore, the adjacent upland monitoring well logs included in the RI/FS did not indicate 20 feet of silt anywhere in the aquitard (URS 2007, 2008). In monitoring well MW-25a, the aquitard was observed to be 23 feet of clay with no silt. Therefore, it was unreasonable for Weston to assume that 20 feet of silt was present in the aquitard. The more reasonable assumption would be to evaluate the aquitard as a single, thicker clay layer.

Additional observations of a thinner aquitard and silt layer are documented in the RI, which includes a site plan of historic subsurface exploration and associated logs (URS 2007). A series of five soil borings (88-1 to 88-5) performed in 1989 were conducted 20 to 150 feet upland of the shoreline. An aquitard thickness that ranges from 13.5 to 40 feet with an average thickness of 23.7 feet is observed in the logs. The thickness of the silt layer of the aquitard ranged from 0 to 17.8 feet, with an average thickness of 9.1 feet. The observations from the boring logs reveal that Weston's assumption of a 28-foot-thick aquitard that is composed of 20 feet of stiff silt is overly optimistic and does not effectively represent known conditions that would not favor a dry excavation remedy. A proper representation of these known site conditions is essential in the analysis to ensure that it properly reflects conditions at the Site.

***Dredge Depth beneath Wood Waste.*** The depth of excavation projected for nearshore sediments is based on the depth to which sediment tPAH concentrations exceed 9.5 ppm, as mandated by the ROD. Figure 3 summarizes currently available data on the anticipated thickness of surficial sediments requiring removal. Weston assumes 5 feet for the removal depth of contaminated sediments beneath the wood waste. The basis for this value is not known, as no reference was provided. The RI/FS mentions that contaminated sediments extend to depths of up to 10 feet in some locations (URS 2007, 2008). Assuming a 5-foot sediment removal depth is likely to under-predict the extent of sediment removal. Deeper removal depths will increase the load on the sheetpile walls and provide less resistance to basal instability.




**SOURCES**: URS, DCI Environmental, Burns & McDonald, Sevensen Environmental Services, et al.
**HORIZONTAL DATUM**: Wisconsin County Systems, Ashland County, U.S. Feet.
**VERTICAL DATUM**: Unknown.

**LEGEND**:

Approximate Extent of Sediment tPAH Contamination (per URS 2008)

SD-125 Sediment Sampling Location and Designation

9 Anticipated Thickness of Sediment Removal in Feet (tPAH > 9.5mg/kg)

6 Contours of Anticipated Sediment Removal Thickness in Feet

200-Foot Offset from Shoreline

0 120
Scale in Feet

L:\AutoCAD Project Files_Projects\0851-Xcel Energy Inc\Ashland-Northern States Power Lakefront\Conceptual Illustrations Figure 2.dwg FIG 3

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ANCHOR QEA

**Figure 3**
Summary of Anticipated Sediment Removal Thickness
Ashland/NSPW Lakefront Superfund Site

***Artesian Head in Aquifer.*** Weston assumes a value of 617.1 feet for the artesian head, which is consistent with previous studies. The RI/FS mentions that an artesian pressure head greater than 12 feet above the lake water elevation has been reported in some nearshore monitoring wells (URS 2007, 2008). Therefore, the value used by Weston is relatively conservative and appears to appropriately reflect potential site conditions.

***Summary***. In its development of a single soil profile, Weston attempts to make use of very limited in-water data but in the process made multiple assumptions that indicate site conditions are more favorable for dry excavation. Dry excavation is ideally, and most commonly, designed based on subsurface information and geotechnical data that are in close proximity to a site. In the case of this Site, the relative lack of subsurface explorations leads to a high degree of uncertainty and the resulting need for purposely conservative assumptions. Weston does not account for this consideration properly and, therefore, does not effectively assess the feasibility of dry excavation. Table 3 summarizes the discrepancies between Weston's assumptions and Anchor QEA's interpretation of conditions that should be considered for the Site.

**Table 3**
**Comparison of Soil Profiles**

| Element of Soil Profile | Weston's Assumption | Anchor QEA Interpretation of Appropriate and Representative Conditions |
|---|---|---|
| Lake water elevation | 602 feet | 603 feet |
| Wood waste elevation and thickness | N/A | N/A |
| Top elevation of surficial sediment | 594.5 feet | 590 feet |
| Thickness of surficial sediment layer | 8.5 feet | 8.5 feet |
| Elevation of contact between surficial sediment and aquitard (Miller Creek Formation) | 586 feet | 581.5 feet |
| Thickness of aquitard | 28 feet | 23 feet |
| Composition and unit weight of aquitard (i.e., clay and silt) | Clay – 8 feet<br>Silt – 20 feet | Clay – 23 feet<br>Silt – 0 feet |
| Dredge depth beneath wood waste | 5 feet | 8.5 feet |
| Artesian head in aquifer | 617.1 feet | 617.1 feet |

Notes: N/A = not applicable

### 2.3.2 Soil Properties

Weston assumed soil properties are detailed below. Alternative values derived from Anchor QEA's independent evaluation of these data are also presented.

#### 2.3.2.1 Representative Blow Count

Results from in situ density testing via blow count (the number of blows from a falling hammer to drive a sampler) were compiled for each soil unit identified, and an assessment of the reliability of these data was made. Weston discards high blow count values that are inconsistent with the majority of these data. This practice is considered standard, as blow counts can be artificially inflated due to obstructions or overfilling of the sampler. In common geotechnical engineering practice, blow counts are used for estimating the density of cohesionless soils (granular soils; i.e., sands and gravels) or are used to determine the properties of cohesive soils (i.e., clays and silts). Because geotechnical data from in situ or laboratory tests were not (and still are not) available for the Site, Weston's use of blow counts for cohesive soils is the only option, but it is important to keep in mind that the use of published correlations is subject to significant uncertainty and statistical "scatter."

#### 2.3.2.2 Total Unit Weight

Weston correlates representative blow count values to soil unit weights by using recommended values obtained from engineering literature. Although the exact reference is not cited by Weston, this approach is generally considered conservative for most design scenarios, because it produces slightly high estimates for unit weight. However, for analyzing bottom blowout, high estimates for unit weight are not conservative, because they overestimate the soil weight that is resisting the uplift force from artesian conditions. A more appropriate approach for this analysis would be to select an appropriate value from a typical range of unit weights for the soil types and loading conditions being analyzed. Table 4 suggests a typical range of soil unit weights for cohesive soils based on shear strength.

**Table 4**
**Cohesive Soils – Typical Values**

| Cohesion (psf) | Saturated Unit Weight (pcf) | Submerged Unit Weight (pcf) |
|---|---|---|
| > 3,000 | 120 to 140 | 60 to 80 |
| 1,500 to 3,000 | 115 to 135 | 55 to 75 |
| 750 to 1,500 | 105 to 125 | 45 to 65 |
| 375 to 750 | 90 to 110 | 30 to 50 |
| < 375 | 90 to 100 | 30 to 40 |

Notes:
Adapted from Fang 1991.
pcf = pounds per cubic foot
psf = pounds per square foot

When assuming a direct relationship between soil unit weight and shear strength, it is observed that a value of between 110 and 120 pounds per cubic foot (pcf) would be suitable for clay and silt, respectively (i.e., shear strengths between 660 and 1,250 pounds per square foot [psf], respectively). Weston potentially overestimates the unit weights for clay and silt by nearly 15 and 10 pcf, respectively, which misleadingly indicates a more stable condition. Given the nature of how unit weights were determined and the associated uncertainty with the analysis method, more conservative values should be used at this stage of design.

### *2.3.2.3 Undrained Shear Strength*

The use of blow counts to estimate the shear strength of soils is a standard and well-documented practice in the geotechnical engineering industry. However, it is widely recognized that correlations of blow count values to undrained shear strength can be unreliable for clay, and in the case of natural silt deposits, it is discouraged (Duncan and Wright 2005).

As previously discussed, Weston derives representative blow counts for clay and silt in a relatively conservative manner, as high values were routinely discarded. Therefore, it is reasonable to use these values to determine at least an index of the undrained shear strength. However, the correlation should also include the application of strength reductions, to account for key factors that will affect the undrained strength of the cohesive soils, most notably, disturbance effects as discussed below.

**Disturbance from Sheetpile Installation.** Weston uses strength values that do not account for disturbance of the soil from sheetpile driving. As sheetpiles are driven, the fabric of the clay's soil matrix (i.e., orientation and bonding of clay platelets) is disturbed most heavily at the soil-sheetpile interface. As a result, the undrained shear strength would be better represented by the residual undrained shear strength, rather than the peak undrained shear strength, which Weston applies in its analysis. The reduced dimensions of the dry excavation "cells" as proposed by Weston will require more sheet pile in a tighter grid spacing, which will further impact sediment strength.

**Strength Loss due to Creep.** The importance of this factor is mentioned in American Society of Civil Engineers (ASCE) Special Publication 74 (1997), which recommends the following consideration when analyzing bottom instability:

> Where bottom heave is a problem, either the height of the excavation must be limited, the embedded wall section designed to resist the failure, or special construction procedures used. In this situation, factors such as loss of strength due to creep and effects of anisotropy can be significant.

In a study of medium plastic clay, compressive strengths decreased by approximately 30 percent as time to failure increased from 10 minutes to 1 week (Duncan and Buchignani 1973). The unconfined compressive strength parameter, as derived from Weston's correlation, neglects the effects of strength loss due to creep. Therefore, the available strength of the soil at the end of construction, when stability is most critical, would likely be less than estimated by Weston.

**Failure Mode.** While Weston assumes that the mode of failure for bottom blowout was analogous to soils failing in compression, a more representative mode of failure for bottom blowout would be direct shear or extension, because the driving force is uplift from the artesian pressure. In a series of studies, the effects of stress orientation at failure were examined relative to the undrained shear strength. A key conclusion from the studies is that undrained strengths can be reduced by 20 percent or more when the principal failure stress changes from vertical to horizontal (Duncan and Seed 1966a, 1966b).

ASCE Special Publication 74 (1997) provides further discussion in regards to the importance of failure mode for excavation designs in clay:

> In special cases involving deep deposits of soft clay, it is advisable to consider performing a supplemental series of triaxial extension and direct simple shear tests. Such a procedure simulates the loading path exerted on the soil. Experience has shown that strength in the passive and radial shear zones can be lower than that in the active zone due to soil anisotropy. These effects lead to a lower stability condition than might be assumed on the basis of compression tests only.

**Partial Drainage.** Soils that drain during loading (i.e., without generating excess porewater pressure) fail at significantly lower stress states when subjected to tensile forces rather than compressive forces. The uplift force from the artesian head will create tensile forces and be more reflective of a direct shear of extension failure mode. It is expected that the dry excavation cells will be subjected to the loading conditions slowly enough for excess porewater pressures to not fully dissipate in the cohesive soils and a partial drainage is most likely to occur.

Although assessing the effects of partial drainage on strength requires different sampling and testing procedures than those performed, it is expected that at least some partial drainage would occur in the cohesive soils, which would result in lower shear strength.

**Summary.** While Weston uses a strength correlation common in geotechnical practice, the selected strength value does not appear to account for the above-mentioned factors. To best represent the undrained shear strength of the soil, a strength reduction between 20 and 50 percent should be applied to the soil layers for use in the analyses.

#### *2.3.2.4 Internal Friction Angle*

The approach used by Weston in deriving the internal friction angle for cohesionless soils is consistent with common practice, and the results are in agreement with other published correlations.

#### *2.3.2.5 Vertical Permeability*

The values reported by Weston are consistent with typical correlated values for the identified soil types and appear to be reasonable estimates. Again, the variability of the correlations should be considered when performing analyses involving permeability.

## 2.4 Summary of Site Characterization Conclusions

After evaluating Weston's approach and its assumptions used to derive soil properties for the identified soil units, many of Weston's selected engineering parameters would lead to a misleadingly favorable conclusion regarding the stability of dry excavation. A comparison of Weston's assumed values for clay and silt and values obtained through Anchor QEA' s independent evaluation of the conditions specific to the Site and design are presented in Table 5.

**Table 5**
**Summary of Differences in Soil Properties between Weston and Anchor QEA Soil Profiles**

| Soil Unit | Soil Property | Weston's Value | Anchor QEA Independent Evaluation Value[1] |
|---|---|---|---|
| Clay component of aquitard | Unit Weight (pcf) | 124.5 | 110 |
| | Undrained Strength (psf) | 660 | 330 to 530 |
| Silt component of aquitard | Unit Weight (pcf) | 130 | 120 |
| | Undrained Strength (psf) | 1,250 | 630 to 1,000 |

Notes:
1 Strength reductions between 20 and 50 percent were applied to produce the reported range.

Note that the silt layer component is not necessarily present in the aquitard to the extent that Weston assumes (refer to discussion of soil profile in Section 2.3.1); the least-favorable condition assumption would not include a silt layer at all.

# 3 EVALUATION OF BOTTOM INSTABILITY ANALYSES

## 3.1 Summary

The stability of the foundation soil at the base of an excavation is critical for not only completing the work as designed but also to protect construction workers, inspectors, and other bystanders from failure of the excavation walls. It is the design engineer's responsibility to perform a proper evaluation of possible failures and to produce a design that suitably guards against failure, as reflected in the design's factor of safety (see Section 1.3).

Weston performed analyses of dry excavation stability and formulated a conceptual stabilizing system incorporating the use of structural barriers to create multiple smaller excavation cells. Anchor QEA has performed an independent evaluation of Weston's analyses and has determined that its results are misleading as they related to the adequacy of the excavation cell design. Anchor QEA's primary concerns with Weston's analyses are that they:

- Assumed soil and water conditions that are more favorable than are known to exist
- Modified published design formulas in a manner that is not supported by peer-reviewed engineering literature
- Targeted a factor of safety that is too low given the uncertainties inherent in site properties and critical forces

Anchor QEA concludes that the required excavation cells would be significantly smaller than those envisioned by Weston and would potentially need to vary widely across the Site, which would not only result in a high risk design in terms of threat to life safety but would also make construction highly complex, risk-heavy, and possibly unbiddable. In addition, the potential need for additional sheetpiles on closer spacing could further spread contamination causing irreversible environmental damages as contaminants adhere to the driven sheetpile. Furthermore, from a procedural standpoint, the concept of subdividing the dry excavation area into numerous cells deviates significantly from the remedial action described in the ROD and evaluated in the FS. Use of cells will pose greater costs and environmental impacts than the remedial remedy envisioned by the ROD.

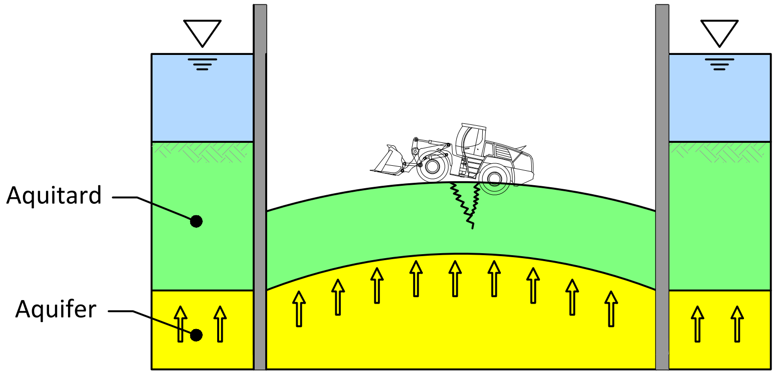
## 3.2 Significance of Basal Heave and Bottom Instability

The term basal heave is used frequently in the Weston Report, and by Foth in its 2009 memorandum, to signify the process whereby elevated hydrostatic pressures exceed downward resisting forces of sediment and water weight, resulting in upheaval and failure of the excavation bottom. Weston discounts the seriousness of basal heave, describing it as "the potential for the bay bottom excavation surface to rise in elevation," stating this to be only a problem of "usability" and that it does not "equate to failure" (Weston 2009). In Anchor QEA's opinion, this assessment reflects only the narrowest possible definition of basal heave and its implication. Even a cursory review of geotechnical literature would reveal the multiple destabilizing effects that unbalanced upward artesian pressure can have on dry excavation.

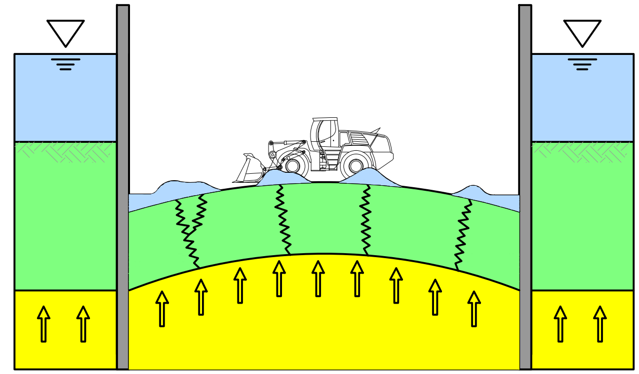
A condition of excessive hydrostatic pressures can be expected to have more than one effect. It is important to properly distinguish these effects, its proper terminology, and its implications on project success and human safety to properly appraise the results of these analyses. For the purposes of this independent evaluation, Anchor QEA uses the terms "bottom upheaval" and "shear instability" to represent two distinct forms of failure that could occur in response to excessive artesian pressures acting below an excavated area. Figure 4 provides general, conceptual illustrations of the progression of failure that could result from unbalanced hydrostatic pressures from below.

Bottom upheaval is the tendency of the ground surface to be pushed upward in response to elevated artesian pressures. The following is an excerpt from ASCE Special Publication 74 (1997) regarding to bottom upheaval or blowout:

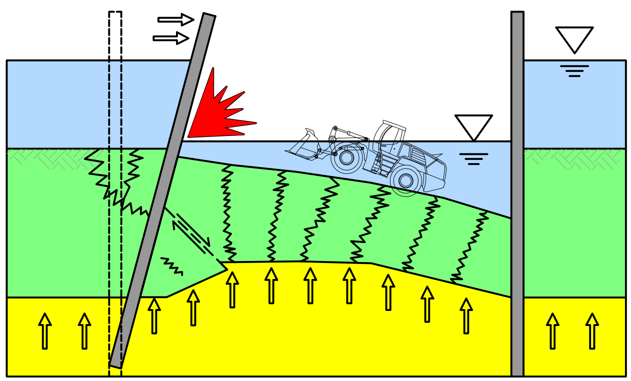
> If bottom blowout or boiling occurs, it can lead to complete failure of the bracing system by causing loss of toe support for the walls. Therefore, it is of utmost importance to identify this problem before construction.




a) Uplift of bottom soil along sheetpile walls and weakening foundation soil, which can lead to:



b) Rupturing from artesian uplift and uncontrolled flow into excavation, which can lead to:



c) Loss of support to sheetpile wall due to weakened foundation soil from uplift, and potential sidewall failure.

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**Figure 4**
Conceptual Illustrations of Bottom Instability Failure Development
Ashland/NSPW Lakefront Superfund Site

Meanwhile, shear instability is the condition where the bottom soils undergo shear failure that destabilizes the excavation's supporting walls (and is the more typical meaning of basal heave as presented in engineering literature). This condition is mentioned by Clough and O'Rourke (1990), who advise the following:

> …if piezometric pressures in an aquifer underlying an excavation are not properly reduced, heaving of the base can occur, leading to loss of passive restraint for the wall.

The uplift of the bottom surface will most certainly result in a change in ground elevation but that is only one manifestation of the failure and possibly the least serious. The movement of the ground surface—the basal heave itself—is necessarily the result of a failure mechanism taking place in the confining layer (aquitard) that separates the elevated head in the aquifer from the ground surface above. It is highly likely, and potentially inevitable, that this extension and ground movement would be accompanied by the classic signs and effects of soil failure—namely extension cracks and jointing within the confining unit itself and a commensurate reduction in its soil strength. The implications could include one or more of the following effects:

- Creation of new available pathways for upward water flow from the aquifer, which could undergo gradual erosion and increase of flow as the water moves through cracks and fissures. The water would enter the dry excavation area and counteract the efforts to keep the area dry
- Changes to groundwater flow in the aquifer poses risk of mobilizing the DNAPL plume
- Loss of strength in the subgrade soil mass will complicate and possibly endanger surface equipment and workers
- Loss of strength and deflection of the subgrade soil mass will also lead to loss of passive soil support to the embedded wall structures, necessary for wall support, causing the walls to collapse and catastrophic loss of containment of Lake Superior into the work zone

While describing the scenario of unbalanced hydrostatic pressure with the singular term basal heave is not necessarily misleading, Weston's representation of basal heave as an issue of mere "usability" under-represents its potential destabilizing effect. This under-representation creates a problematic precedent for decision making at the Site, and one that Anchor QEA strongly opposes. It is imperative that NSPW, as well as regulatory representatives, not underestimate the potentially damaging effects of this condition.

## 3.3 Assumptions and Approach used by Weston

The issue of bottom instability is addressed by Weston through two methods and is presented in its report as the following:

- Excavation bottom upheaval analysis (Appendix C of the Weston Report)
- Shear instability analysis (Appendix D of the Weston Report)

### *3.3.1 Weston Excavation Bottom Upheaval Analysis*

The upheaval analysis performed by Foth in its 2009 memorandum was modified by Weston to include resistance from soil shear strength. In doing so, Weston assumes a rectangular failure mass for the purposes of calculating maximum cell dimensions of the dry excavation. The equation for factor of safety against basal heave was modified to produce the following form:

$$Factor\ of\ Safety = \frac{\sum_i^n \left(\gamma_{t,i} \cdot (B \cdot L) + Su_i \cdot 2(L+B)\right) \cdot h_i}{\gamma_w \cdot (z_{ART} - Z_{CA}) \cdot (B * L)}$$

Where,

$\gamma_{t,i}$ = total unit weight of the soil unit between the excavation base and aquifer (pcf)

$Su_i$ = undrained shear strength between the excavation base and aquifer (psf)

$h_i$ = thickness of soil unit between the excavation base and aquifer (feet)

$B$ = width of excavation cell in plan view

$L$ = length of excavation cell in plan view

$z_{ART}$ = total head of the artesian aquifer (feet; mean sea level [MSL])

$z_{CA}$ = elevation at the top of the confined aquifer (feet; MSL)

$\gamma_w$ = unit weight of water (62.4 pcf)

For use of the equation, Weston makes the following assumptions:

- The 3.5 feet of undredged sediment contributes negligible shear resistance.
- A minimum factor of safety of 1.25 is acceptable.

Using Weston's soil profile and properties discussed earlier in Section 2 of this document, Weston concludes that an excavation cell with dimensions of 150 feet by 200 feet (length by width) would result in a factor of safety of at least 1.25 against basal heave. In Anchor QEA's opinion, this factor of safety is insufficient, as discussed in Section 3.4.1.

### 3.3.2 Weston Shear Instability Analysis

Weston's analysis evaluates the potential for unbalanced hydrostatic forces to cause shear failure below the excavation and its supporting walls. Weston uses the cell dimension derived from the bottom upheaval analysis to perform what they termed a "basal heave shear failure instability analysis," to verify that the cell dimensions are suitable with respect to the conceptual design (Weston 2009).

In performing this analysis, Weston uses a negative bearing capacity method with the Bjerrum and Eide (1956) formulas and methodology. This form of analysis is the typical meaning of basal heave in engineering literature. For use of the method, Weston makes the following assumptions:

- A minimum factor of safety of 1.2 is acceptable.
- The lake water acts a surcharge load on the outward side of the excavation.
- The 3.5 feet of undredged sediment inside the excavation is part of the clay layer and has matching soil properties.
- The effects of the artesian pressure can be accounted for by including it with the lake water as surcharge load.

Weston concludes that a dry excavation cell with dimensions of 150 feet by 200 feet will have a factor of safety of 1.63 against shear instability. In Anchor QEA's opinion this conclusion is inadequate, as discussed in Section 3.4.2.

## 3.4 Independent Evaluation of Weston's Assumptions and Approach

The ROD does not describe, mention, nor reference any of the evaluations Weston performed for the bottom upheaval or the shear instability analysis. Furthermore, there is no evidence that a third-party review of Weston's evaluations was ever performed. Weston's evaluation and conclusions appear to have been unchecked and unverified prior to the USEPA's publishing of the ROD in 2010. The following sections present Anchor QEA's independent evaluation of Weston's assumptions and technical approach as well as revised analyses that demonstrate that dry excavation is not feasible and would seriously endanger human safety and the environment if implemented.

### *3.4.1 Anchor QEA Excavation Bottom Upheaval Analysis*

The original analysis performed by Foth in its 2009 memorandum is consistent with the form of bottom upheaval (or blowout) analysis presented in multiple technical references, design manuals, and other forms of design guidance (Bowles 1996; Gue and Tan 1998; Chen et al. 2000; Rutherford et al., 2005; Bray 2011). The form of the equation for bottom upheaval consistently supported by references is as follows:

$$Factor\ of\ Safety = \frac{\sum_i^n \gamma_{t,i} \cdot h_i}{\gamma_w \cdot (z_{ART} - Z_{CA})}$$

Where,

$\gamma_{t,i}$ = total unit weight of the soil unit between the excavation base and aquifer (pcf)

$h_i$ = thickness of soil unit between the excavation base and aquifer (feet)

$z_{ART}$ = total head of the artesian aquifer (feet; MSL)

$z_{CA}$ = elevation at the top of the confined aquifer (feet; MSL)

$\gamma_w$ = unit weight of water (62.4 pcf)

The bottom upheaval analysis performed by Weston includes a modification of Foth's analysis that attempts to account for shear resistance from the soil. While the standard equation previously presented and used by Foth in its 2009 memorandum is a proven form of a commonly performed analysis, the approach proposed by Weston is not represented in standard geotechnical literature. Furthermore, Weston's approach appears to be subject to significant uncertainties and variability regarding the soil shear strength mobilized at the time of failure and the geometry and dimensions of the failure mass. These uncertainties introduce a greater risk of failure if unaccounted for in either the parameters used in the analyses or in the factor of safety by which the dry excavation cells are designed. As demonstrated below, Weston does not account for these uncertainties and hence, the 150-foot by 200-foot dry excavation cell they propose is much less safe than reported and has the potential to catastrophically fail if implemented.

Another concern with respect to Weston's analysis is the minimum factor of safety referenced. In general, the factor of safety serves as a suggested benchmark for design purposes to ensure an appropriate degree of conservatism is applied to avoid failure. Therefore, the appropriate minimum factor of safety for any analysis is based on the uncertainties associated with the design along with considerations for protection of human life. The following excerpt is from Duncan and Wright (2005) and refers to selection of a minimum factor of safety:

> The value of factor of safety used in any given case should be commensurate with the uncertainties involved in its calculation and the consequences that would ensue from failure. The greater the degree of uncertainty about the shear strength and other conditions, and the greater the consequences of failure, the larger should be the required factor of safety.

As an example, the U.S Army Corps of Engineers (USACE) recommends a minimum factor of safety of 1.25 for slope stability only when the uncertainty of analysis conditions is small and the cost of repair is comparable to the incremental cost to construct a more conservative design. The USACE slope stability manual (1970) makes the following note with respect to a small uncertainty:

> The uncertainty regarding analysis conditions is smallest when the geologic setting is well understood, the soil conditions are uniform, and thorough investigation provide a consistent, complete, and logical picture of conditions at the Site.

Weston's inclusion of soil shear strength in the bottom upheaval analysis represents a modification of standard and industry-accepted design guidance and results in a potentially misleading improvement to the stability of the excavation. The analysis also introduces numerous uncertainties that are not accounted for and, therefore, not reflected in the minimum factor of safety recommended by the cited literature. In addition, the design guidance and recommended factor of safety is based on the assumption that the excavation will be designed based on explorations and geotechnical data performed in close proximity to the area of interest. A higher minimum factor of safety should be used when consideration is given to the limited amount of data available within the area of potential dry excavation.

The implications to this project are clear: given the pre-design nature of the analysis, the sizable field data gaps known to exist, the high degree of site variability, and the serious and irreparable nature of the potential failure modes, a conservative—rather than aggressive—approach to the analysis is absolutely necessary. This appropriately cautious approach is demonstrated by the selection of a minimum allowable factor of safety. Specifically, Anchor QEA believes that the unorthodox and highly inexact nature of Weston's modified design formulas is inconsistent with the minimum factor of safety of 1.2 that they targeted and that a higher factor of safety (of 1.5) should be used instead. Considering the guidance from Duncan and Wright (2005) and perspective of the USACE (1970), Anchor QEA strongly believes that standard design guidance should be used for assessing bottom blowout, with a minimum acceptable factor of safety of 1.5, for this stage of design.

Anchor QEA re-evaluated the bottom upheaval analysis by independently performing a series of analyses related to excavation bottom upheaval. Altogether, five forms of analyses were undertaken. The first three involved using Weston's modification to the excavation bottom upheaval formula to independently determine how small dry excavation cells would need to be constructed in order to reach certain factor of safety levels.

These analyses are as follows:

1. Use of Weston's modified excavation bottom upheaval formula with Weston's assumed soil profile and properties, targeting a minimum factor of safety of 1.5.

2. Use of Weston's excavation bottom upheaval formula with Weston's soil profile and Anchor QEA's condition-specific soil properties, targeting a minimum factor of safety of 1.2.
3. Same use as analysis 2, except targeting a minimum factor of safety of 1.5.
4. Use of the customary, unmodified excavation bottom upheaval formula (consistent with geotechnical literature), with Weston's soil profile and properties.
5. Use of the customary, unmodified excavation bottom upheaval formula, with Anchor QEA's reasonably conservative soil profile and condition-specific soil properties.

The final two analyses were conducted using the customary, unmodified excavation bottom upheaval formula that is found in the geotechnical literature. This formula reflects the concept that the upward- and downward-acting forces are applied regardless of whether the excavation is completed in individual cells or not. Each analysis therefore results in a single factor of safety independent of excavation cell size. The results of Anchor QEA's evaluation are summarized in Table 6.

**Table 6**
**Summary of Re-Evaluated Bottom Upheaval Analysis**

| Analysis Procedure (See Text) | Targeted Minimum Factor of Safety | Required Maximum Dimensions of Excavation Cells (Length by Width; feet) | Resulting Factor of Safety |
|---|---|---|---|
| 1 | 1.5 | 100 x 65 [1] | 1.5 |
| 2 | 1.2 | 120 x 100 [1] | 1.2 |
| 3 | 1.5 | 65 x 35 [1] | 1.5 |
| 4 | 1.5 | Any size | 1.08 |
| 5 | 1.5 | Any size | 0.69 |

Notes:
1 Weston concluded that an excavation cell size of 150 feet x 200 feet would be appropriate. Anchor QEA's re-evaluation of Weston's approach indicates that excavation cells would need to be significantly smaller.

The results of analyses 1, 2, and 3 shown in Table 6 demonstrate that even when using the terms of Weston's analysis, the allowable size of dry excavation cells that would be needed to achieve stability have likely been overestimated. As previously stated earlier, Weston's analytical procedure is not supported by industry standards, but the analyses previously presented demonstrate the importance and critical nature of selecting the proper factor of safety and soil parameters and how variations in these parameters influence conclusions regarding excavation cell size.

When using Weston's modified formulas for the analysis and recognizing that the modifications differ from standard industry practice, Anchor QEA concludes that excavation cells are indicated as needing to be significantly smaller than Weston's 150-foot by 200-foot estimated dimension. This overestimation is a consequence of the assumptions and approach used by Weston in developing its soil profile, soil properties, and analytical method. Smaller excavation cells would require more sheetpile installation and removal, greater time spans, and a great deal more disturbance to the Site and the underlying aquifer.

Analyses 4 and 5, using the unmodified formula that is supported by engineering literature, implies that regardless of dry excavation cell size the excavation fails to attain reasonable factors of safety. The dry excavation concept is therefore indicated as being infeasible regardless of cell dimensions. The indicated factors of safety (1.08 and 0.69, respectively) are well below acceptable levels for design and implementation, with 0.69 indicating outright failure.

In summary, it is anticipated that the implementation of dry excavation at the Site will result in numerous issues with respect to constructability and project scheduling as a result of the high variability in excavation designs.

### *3.4.2 Anchor QEA Basal Heave Shear Instability Analysis*

Figure 4 illustrates the development of basal heave shear instability. Although dry excavation as envisioned by Weston and the USEPA was found to be an unsafe and unconstructable remedy through the analyses performed in Section 3.4.1, Anchor QEA has reassessed Weston's basal heave shear failure instability analysis (reported as "Excavation Bottom Blowout" in the main text), which analyzes the case of a rectangular excavation cell dimension of 150 feet by 200 feet (width by length). The cell dimensions Weston analyzes were derived from its bottom upheaval analysis and not a true excavation bottom blowout (see Section 3.4.1), as performed by Anchor QEA. The methodology assumed by Weston for the basal heave shear instability analysis is a commonly used in practice to evaluate a two-layer soil profile with a stiffer stratum underlying a softer stratum.

The formula is as follows:

$$Factor\ of\ Safety = \frac{S_{u,1} \cdot \left(N_{c,s} \cdot f_d \cdot f_s\right)}{\gamma \cdot h + q}$$

Where,

$N_{c,s}$ = bearing capacity factor independent of excavation depth (unitless)
$S_{u,1}$ = undrained shear strength of upper clay (psf)
$\gamma$ = total unit weight of outward soil (pcf)
$h$ = depth of excavation (feet)
$q$ = surcharge pressure from free water and artesian pressure (psf)
$f_d$ = depth correction factor; function of excavation depth and width (unitless)
$f_s$ = shape correction factor; function of excavation width and length (unitless)

However, in applying this widely used method of basal heave to its soil profile and site conditions, Weston made two key assumptions:

- Weston included the artesian pressure in its analysis as a force acting upward on the base of the aquitard, which is represented in the formula as an additional surcharge load (similar to the pressure of retained water outside the excavation area).
- The silt must be very thick (i.e., thicker than assumed in its profile) for its bottom upheaval analysis to be consistent with published literature. Therefore, the aquifer and silt layers are treated as if they have similar shear strengths and behavior in response to loading conditions.

The first assumption is perceived as a conservative modification of published design guidance, although it is not supported by engineering literature. The second assumption may not be conservative as the influence of the artesian head pressures in the aquifer could potentially produce significantly lower shear strength than assumed. Verification that modeling of site conditions using these assumptions is conservative should be completed prior to final design. Nonetheless, Anchor QEA performed an independent evaluation of

Weston's 150-foot by 200-foot dry excavation cell design by using, as Weston did, the artesian pressures included as a surcharge pressure and a very thick silt layer (i.e., aquifer and silt have similar shear strengths).

Use of the method requires several charts from engineering literature, which estimate the input parameters based on excavation dimensions, soil stratigraphy, and soil shear strength. In essence, the parameters obtained from the charts are a quantification of the converging stresses associated with the soil and water that is retained outside the excavation walls. This convergence of stresses is most prevalent beneath the excavation bottom and hence produces heave. For a wide excavation, the convergence of stresses from adjacent excavation walls is small and, hence, a larger factor of safety is predicted when compared to a similar excavation design that is narrower. Weston's assumed dry excavation dimensions are demonstrated in its report to have an adequate factor of safety against basal heave (i.e., 1.63), which is primarily a result of the wide excavation width. However, Weston's assumptions in developing its design are demonstrated in Section 3.4.1 to be inappropriate for prevention of excavation bottom blowout from the artesian pressures. Therefore, with consideration of a range of soil profiles and soil properties, Anchor QEA has reassessed basal heave for the 150-foot by 200-foot dry excavation cell that contributes to Weston's conclusion that dry excavation is feasible.

The two key assumptions made by Weston are adopted by Anchor QEA for purposes of these analyses and to remain consistent with the work performed by Weston. Anchor QEA does not recognize Weston's assumptions as being reliable for a conceptual design and believes that greater skepticism should have been reflected in its conclusions. Nevertheless, Anchor QEA reassessed Weston's bottom upheaval analysis assuming Weston's 150-foot by 200-foot dry excavation cell for several different analytical conditions and soil profiles (see Figure 3 for a summary of assumed soil profiles and Table 7 for a summary of analytical results):

1. Reanalysis using Weston's soil profile and properties
2. Reanalysis using Weston's soil profile and Anchor QEA's soil properties
3. Reanalysis using Anchor QEA's soil profile and Anchor QEA's soil properties
4. Back analysis to determine excavation cell dimensions that would be required to reach a factor of safety of 1.5, assuming more representative soil profile and properties

It should be noted that the more representative undrained shear strength values for silt and clay are a 30 percent reduction of Weston's values, which accounts for different factors that contribute to strength loss (see Section 2). This reduction is consistent with the strength reductions applied in the reassessment of Weston's bottom upheaval analysis (Section 3.4.1). To establish a performance standard against failure and endangerment of life safety during construction, multiple technical references and sources of design guidance were consulted to determine an appropriate minimum factor of safety. Of the references reviewed, a minimum factor of safety of 1.5 against basal heave was consistently recommended and will therefore be the benchmark for which conclusions are formulated (NAVFAC 1986; Fang 1991; Bowles 1996). Calculations for the analyses performed are provided as Appendix A, and results are presented in Table 7.

**Table 7**
**Summary of Anchor QEA Results for Reassessment of Weston's Basal Heave Shear Instability**

| Analysis | Factor of Safety | Comment |
|---|---|---|
| 1 | 1.63 | This result and analysis is consistent with Weston's analysis and meets the desired factor of safety, although the assumptions in Weston's analysis are inappropriate |
| 2 | 1.15 | When compared to Analysis 1, the result demonstrates that the potential for basal heave is most sensitive to the undrained shear strength of the upper clay layer. The result of this analysis is below the desired factor of safety and suggests an unacceptable level of safety and risk. |
| 3 | 0.95 | The result demonstrates that a combined effect of a reduced undrained shear strength and a thickened upper clay layer results in substantial susceptibility for basal heave. The result of this analysis is below the desired factor of safety and suggests that failure will likely occur. |
| 4 | N/A | The driving stresses from the surcharge pressure are large enough such that the required bearing capacity factor to satisfy a factor of safety of 1.5 could not be achieved. Therefore, cell dimensions that result in a factor of safety of 1.5 against basal heave cannot be designed for the soil profile and properties assumed, meaning a dry excavation cell of any dimension will not be safe enough. |

The results shown in Table 7 indicate the sensitivity of soil unit thickness and strength to the stability of the dredge in the dry excavation system. For the conditions described for

Analysis 3, results of the method indicate a factor of safety less than 1, which is a prediction that movement of the foundation soil will occur.

In general, basal heave can be a concern for braced excavations where sheetpile walls are not embedded in the foundation soil and when soft soils exist beneath the excavation area. Mitigation of basal heave is typically performed by embedding the sheetpile walls so that potential failure planes are lengthened and result in more resistance from the soil's shear strength. Because penetrating the aquitard through sheetpile embedment could potentially disturb and weaken the soils (as discussed in Section 2), as well as create other concerns such as piping (see Section 4), or potentially cause cross contamination by dragging contamination downward, dry excavation cells supported with cantilevered sheetpile walls may present an unacceptable risk to a contractor requiring the use of small, braced excavation cells. Choosing an approach involving internal bracing would be a very expensive measure and would create a very long project duration that would add substantial cost to the remedial design and, in general, be impracticable.

In the absence of the artesian conditions, basal heave from the retained sediment and lake water would be unlikely. However, artesian pressures could contribute to a rotation- type mode of shear failure, which is a rotation failure that results in upheaval of excavation bottom and destabilization of the cantilever sheetpile wall from the loss of passive restraint. The range of factors of safety from Table 7 (i.e., 0.95 to 1.63) indicates that a basal heave type mode of failure may be a significant risk and should not be dismissed as a negligible design consideration as Weston advocates in its report. Furthermore, Weston neglects to evaluate the global slope stability analysis of an isolated section of the cantilever wall. Global slope stability is a fundamental evaluation that should be performed for every conceptual design that considers soil removal, but was not conducted as part of Weston's analysis.

# 4 EVALUATION OF PIPING ANALYSIS

## 4.1 Summary

The potential of water to flow into the excavation area through "piping" was evaluated by Weston. Piping is when groundwater pressures at the base of an excavation area are high enough to remove foundation soil and cause uncontrolled flow or in extreme cases instability and failure of a design. Figure 5 illustrates the development of excavation failure in response to piping conditions and soil strength loss.

Anchor QEA has found that Weston's analyses overlooked several important factors that could cause poor and unsafe working conditions. These factors include:

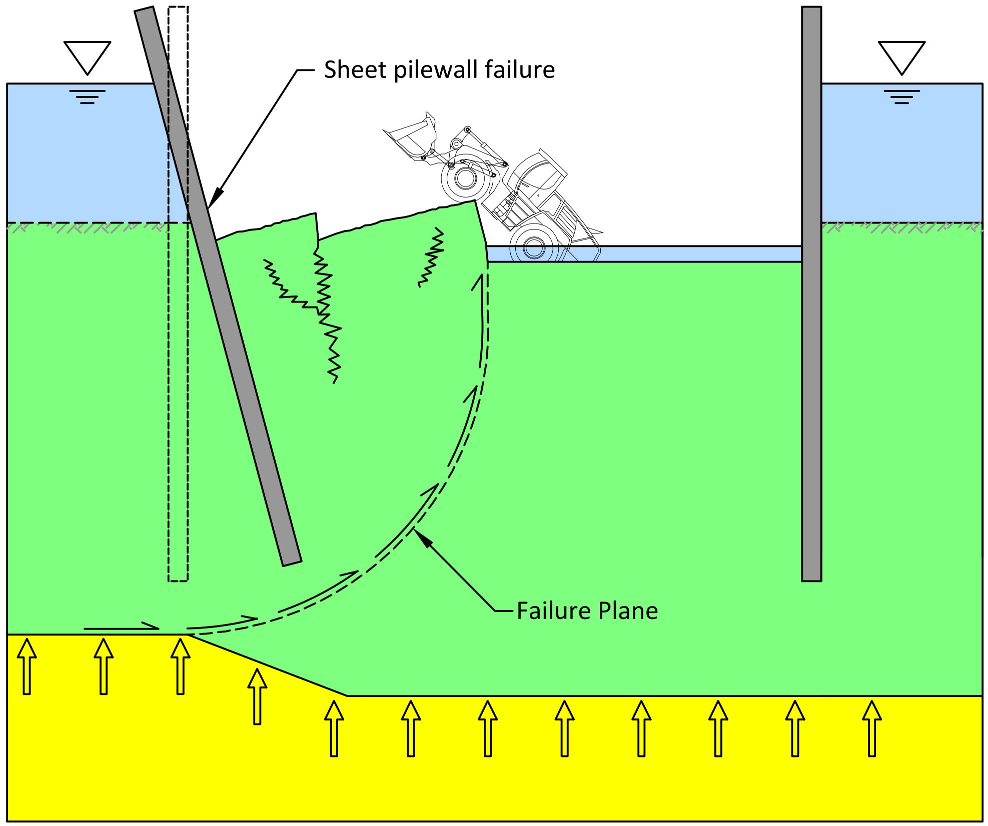
- Existing fissures and fractures within the clay that could act as conduits for upward water flow
- Disturbance from sheetpile embedment through the aquitard, which could create significantly larger pathways for upward flow

In Anchor QEA's opinion, Weston's conclusions are more optimistic than should be expected for the potential of piping in dry excavation cells at the Site.

## 4.2 Assumptions and Approach used by Weston

Weston performed an exit gradient analysis to determine the likelihood of instability of the dry excavation sheetpile walls due to piping and/or fluidization of the excavated bottom. The soil profile and properties summarized in Tables 1 and 2, respectively, were assumed. Weston identified two mechanisms for creating potentially high exit gradients:

1. The upward gradient from the artesian condition through the aquitard and overlying sediment
2. The upward gradient adjacent to the sheetpile resulting from the unbalanced retained lake water and the dewatered excavation interior




Loss of restraint due to pressures of retained soil and free water, weakened further by artesian pressures, is another possible cause of wall failure.

Oct 11, 2012 2:12pm mpratschner L:\AutoCAD Project Files_Projects\0851-Xcel Energy Inc\Ashland-Northern States Power Lakefront\0851-RP-00-FAILURE MODES.dwg Figure-5

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**Figure 5**
Conceptual Illustration of Piping and Wall Failure
Ashland/NSPW Lakefront Superfund Site

Weston evaluated the exit gradient resulting from the first mechanism using SEEP/W, a commercially available software program. The average exit gradient was found to be $2x10^{-5}$ feet/feet. Weston concludes that the exit gradient from the artesian conditions would be negligible, owing to significant resistance to upward flow through the relatively impermeable soils of the aquitard.

The exit gradient resulting from the second mechanism was evaluated using a methodology for a double-wall sheetpile cofferdam. Weston assumes cell dimensions of 150 feet by 200 feet and that the soil column consists of undredged sediment (rather than clay and silt aquitard properties), with a vertical permeability of $10^{-2}$ centimeters per second (cm/sec). This assumption was described as very conservative and produces an exit gradient of 0.187 (expressed as a ratio of head loss in feet divided by flow distance in feet) and resulted in a factor of safety against piping of 5.5, which Weston notes as being higher than the minimum recommended factor of safety of 4 to 5.

## 4.3 Evaluation of Assumptions and Approach

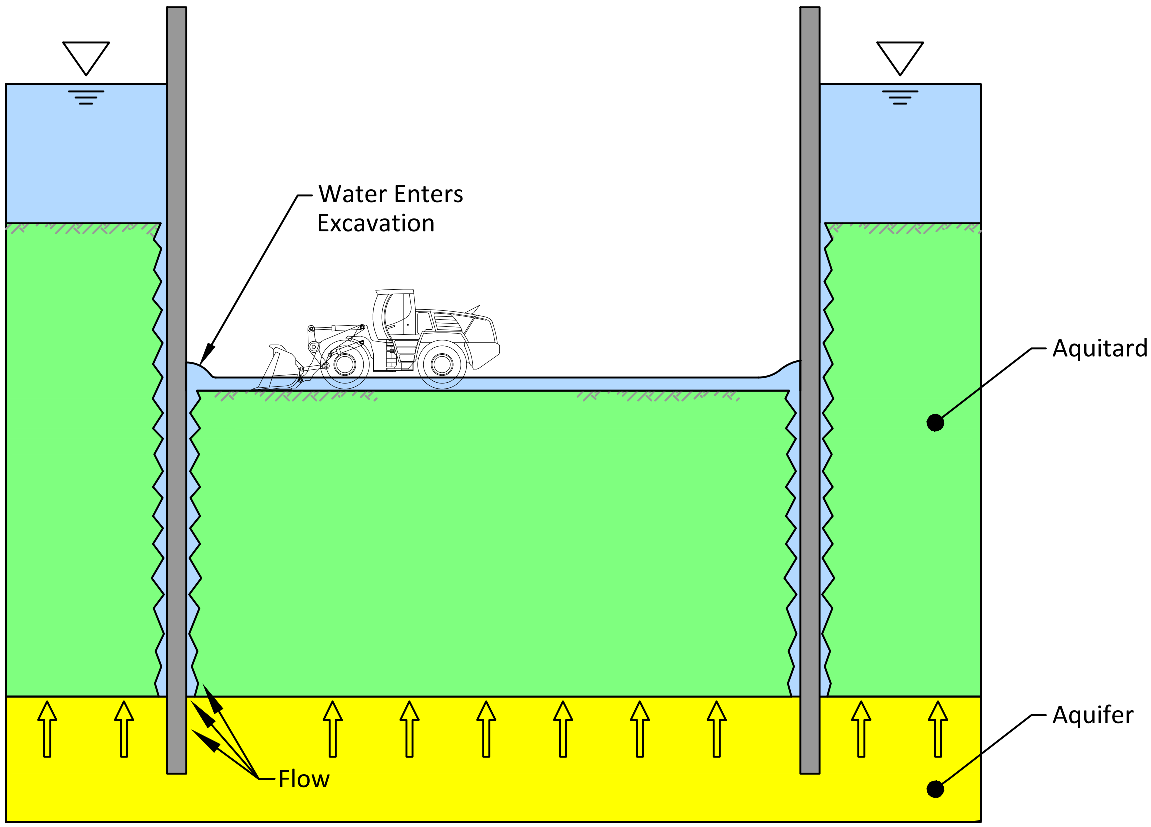
The effects of piping are typically of concern when excavations are performed in cohesionless soils and when a high water table exists. The soils of the aquitard are instead cohesive and have a low hydraulic conductivity. For this reason, piping due to a high exit gradient appears to be of lesser concern than other design considerations previously addressed.

While Weston seems to have adequately demonstrated that piping is not likely to compromise project stability, they failed to acknowledge factors that could lead to higher than predicted flow into the excavation area. These factors include:

- Existing fissures and fractures within the clay that would act as conduits for upward water flow
- Disturbance from sheetpile embedment through the aquitard could create significantly larger pathways for upward flow

ASCE SP 74 (1997) concurs that while the potential for heave can often be lessened by increasing the penetration of the wall, it may be undesirable to drive the sheetpile through a silt or clay stratum at subgrade to a partial penetration into underlying sands, because a ready path for piping can be created along the face of the sheetpile.

Such flow would be another important possible side-effect of the artesian conditions, because the higher flow of water into the excavation area could create unsafe and/or difficult working conditions, produce more water for dewatering and treatment, and compromise the effectiveness of the remedial design. It is also worth noting that full penetration of sheetpiles into the aquifer, followed by its subsequent removal, could permanently compromise the integrity and function of the aquitard layer itself, as is illustrated on Figure 6. Another potentially problematic result of upward flow conditions, which could occur during the remedial construction process, is that the upward flow could disrupt the granular cover layer that the ROD requires over the dredged subgrade (USEPA 2010). In general, these factors increase the potential to compromise the effectiveness of dry excavation.




Installation of sheetpile creates damaged "slot" through aquitard allowing piping through weakened soil and into excavation area.

ANCHOR QEA

**Figure 6**
Conceptual Illustrations of Aquitard Damage and Water Release into Excavation
Ashland/NSPW Lakefront Superfund Site

# 5 EVALUATION OF SHEETPILE DESIGN ANALYSIS

## 5.1 Summary

In order to construct a dry excavation cell, it is necessary to install supporting sheetpiles to a sufficient depth to adequately resist water and soils outside of the excavation area. Weston performs analyses of the depth and type of sheetpile that would be needed for at the Site. Anchor QEA's independent evaluation of this analysis indicates that sheetpiles would very likely need to be installed fully through the aquitard layer into the underlying aquifer, which poses a serious risk of compromising the aquifer and resulting inflow of water into the excavation area. Weston's analysis overestimates soil strengths and aquifer thickness and incorrectly concludes that the sheetpile would not need to penetrate that far.

## 5.2 Assumptions and Approach used by Weston

Weston performed a preliminary sheetpile analysis to determine the minimum embedment depth and stiffness required to keep Lake Superior and groundwater out of the excavation to allow dry excavation. The analysis considers hydrostatic forces from the retained lake water and active earth forces resulting from the soil profile and properties summarized in Tables 1 and 2, respectively. The water elevation in the excavation is assumed to be 2 feet deeper than the final elevation of the excavation bottom.

Weston used PROSHEET, a design software program from Skyline Steel, and a factor of safety of 1.3 for the analysis. Weston concludes that a minimum embedment of 27.4 feet and ASTM-572 steel with a minimum sheetpile section modulus of 25.19 cubic inches per foot ($in^3/ft$) would be required to resist the maximum bending moment.

## 5.3 Evaluation of Assumptions and Approach

Weston mentioned the possibility of lateral forces from wind, waves, and ice but did not factor these key driving forces into its analysis. Including the wind, wave, and ice forces neglected by Weston increases the demand on the sheetpile wall and results in a deeper embedment depth than is determined by Weston. Lake Superior is known as the largest freshwater lake in the world and inclusion of these forces and associated variability into the analyses should be made for any analysis that is part the feasibility phase, which is the most fundamental phase of a design. Weston's sheetpile design currently has the sheetpile tipped a significant distance into the aquitard; therefore, including these potentially large driving forces would likely cause the sheetpiles to be driven through the aquitard layer.

Burns and McDonnell (2009) conducted a separate analysis that included the various loading effects (such ice loading) and concluded that a large diameter cellular cofferdam could be constructed along the project area. This solution is not only projected to be very costly but does not appear to address concerns for the ability of foundation soils (the underlying aquitard) to adequately provide the bearing capacity needed to support such a massive retaining system.

While Weston's assumed soil unit weights appeared to be unconservatively high for the bottom upheaval analysis (discussed in Section 3.4), for the sheetpile evaluation the assumed soil weights appear reasonably high and appropriately conservative. However, as was discussed in Section 2, the assumed undrained shear strength for the cohesive soils as well as other aspects of Weston's soil profile assumptions appear to make the analysis non-conservative.

Even with the non-conservative assumptions used, Weston's resulting estimation of minimum sheetpile embedment is 27.4 feet, which considering the observed variability of the aquitard thickness, likely penetrates through the aquitard and into the confined aquifer below in some locations. Weston assumed an aquitard thickness of 28 feet, although one nearshore exploration showed it to be only 23 feet thick, in which instance the sheetpile would extend well into the aquifer layer.

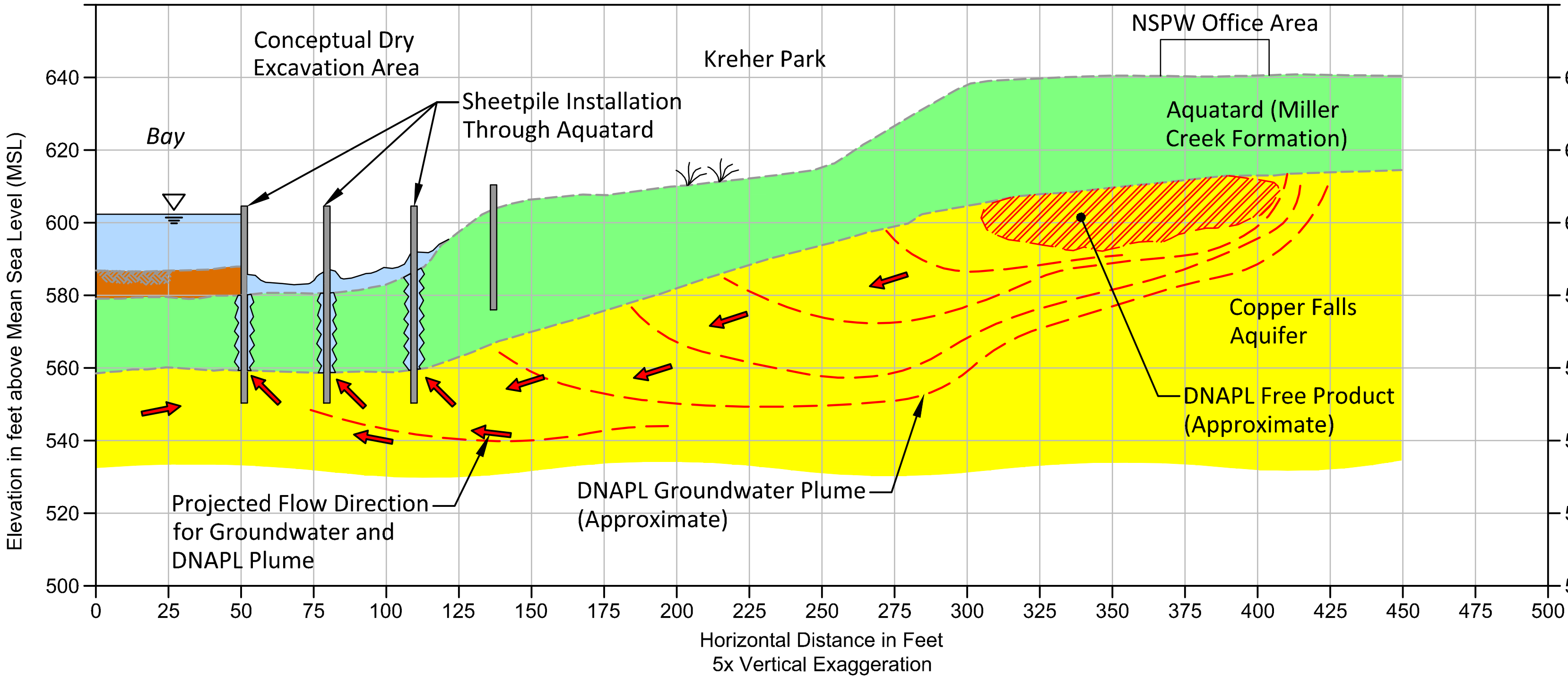
Anchor QEA performed an independent analysis of the conceptual sheetpile design parameters and embedment, using the more reasonably conservative soil profile and condition-specific soil properties developed by Anchor QEA. Similar to Weston's analysis, lateral forces from wind, waves, and ice were not included. As stated previously, these forces could be significant. The water elevation in the excavation area was assumed to be consistent with the top of the aquitard, assumed to represent the bottom of the excavation area. A free-earth support was assumed at the toe of the sheetpile and the minimum embedment required for force and moment equilibrium was determined

The resulting minimum sheetpile embedments for a factor of safety between 1.3 and 1.5 were 37.0 and 41.5 feet, respectively. These results indicate significant penetration through the aquitard and into the confined aquifer, as mentioned in Section 3.2 and depicted on Figure 6, which would cause significant long-term aquifer issues.

In addition to the previously mentioned consequences, it is likely that the significant driving depth of sheetpiles required to maintain a stable and safe dry excavation area would ultimately cause irreversible environmental harm by damaging the aquitard, resulting in changes to ground water flow within the artesian aquifer. Increased aquifer flow caused by aquitard damages would have the potential to mobilize the DNAPL plume, as illustrated on Figure 7. Increased aquifer flow could also impact groundwater levels in the area impacting existing wells.

L:\AutoCAD Project Files_Projects\0851-Xcel Energy Inc\Ashland-Northern States Power Lakefront\0851-RP-00-FAILURE MODES.dwg Figure-7

Oct 11, 2012 2:13pm mpratschner




**LEGEND**:

Projected Flow Direction for Groundwater and DNAPL Plume

**Figure 7**
Effects of Dry Excavation Concept on Groundwater and DNAPL Plume
Ashland/NSPW Lakefront Superfund Site

# 6 POTENTIAL IMPLEMENTABILITY OF ALTERNATIVES TO DRY EXCAVATION

While the dry excavation approach has multiple problems with safety and implementation, better-suited, technically defensible alternatives are available for the Site. This section presents two such alternatives, both of which are discussed in the FS and the ROD: wet dredging (Alternative SED-4 in the FS and ROD) and sediment containment in a CDF (Alternative SED-2 in the FS and ROD).

## 6.1 Wet Dredging Alternative

Section 12.2 of the ROD recognizes the potential application of the wet dredging remedy to the Site, although the remedy is subjected to a pre-design pilot test in which the adequacy of the technique would need to be proven, stating:

> If a pre-design pilot test for wet dredging of the near shore area is conducted and indicates that dredging rather than dry excavation within the near shore area will attain the established performance standards and can be conducted in a manner protective of human health and the environment, then EPA, in consultation with WDNR, will recommend that an alternate remedy (dredging) be implemented for both near shore and outer shore sediments and EPA will publish its decision in an ESD.

In Anchor QEA's opinion, a wet dredging program can be successful and efficiently implemented at the Site in a manner that will satisfy both the USEPA and WDNR, as long as reasonable performance standards and measures of achievement are established, consistent with wet dredging performed at other sites throughout the country. However, in Anchor QEA's opinion, subjecting a wet dredging remedy to a pre-design test phase or pilot test (as the ROD terms it) is an unnecessary step that would subdivide a valid remedial solution into two separate mobilization steps with no attendant environmental benefit. Rather, Anchor QEA recommends that if wet dredging is selected as the cleanup approach for the Site, a pilot study be performed not as a pre-design test stage but rather as the initial portion of the remedial action, serving as a stage in which the dredging process can be optimized. The remainder of dredging could proceed immediately thereafter with the contractor refining its methods appropriately.

While the dry excavation approach is considered by the USEPA to allow a more precise removal operation and the minimization of potential migration of contaminants into the main body of the lake, it is Anchor QEA's opinion that a well-planned and properly conducted wet dredging program will allow the work to meet performance standards in a manner that is equally, if not more, protective of human health and the environment.

Compared to the problematic concept of dry excavation, there is considerably less risk and fewer additional studies needed to evaluate a wet dredging program, provided, again, that the performance standards are thoughtfully and reasonably established. In addition, Anchor QEA anticipates that the cost of a wet dredging program for the full scale remediation would likely be substantially less than the proposed dry removal. Most importantly, a wet dredging program avoids the dangers of harm to the environment and human health that are posed by the dry excavation method.

## 6.2 Confined Disposal Facility Alternative

Alternative SED-2 in the FS envisions containment of sediment in an on-site nearshore CDF (URS 2008). This remedial concept, as presented in the FS, features a permanent barrier constructed offshore using earth materials, sheetpile walls, or similar structures and chemically affected sediment is placed within the enclosure that is formed. An upper layer of clean material is placed over the sediment to raise grades to a desired elevation and to isolate sediments from the environment. Figure 8 presents the footprint and layout of a CDF as envisioned by the SED-2 alternative. Figure 9 presents a conceptual cross section through the CDF showing two different cap alternatives.

Although this alternative was not carried forward by the USEPA as a preferred alternative in the ROD, Anchor QEA believes that it can be an environmentally protective, technically efficient, and cost-effective strategy for confining sediments at the Site. A CDF has the added advantages of avoiding the impacts to the Site, roads, and neighboring community that would be caused by establishing a large-scale sediment treatment and hauling operations. The CDF could support redevelopment goals of the community, the city, and local residents as described in the City of Ashland's Waterfront Development Plan (City 2002). There are numerous examples across the country in which CDFs have been used successfully to confine contaminated sediments.

In order to maximize the effectiveness of the CDF alternative, the facility would ideally be designed with enough capacity to contain all of the Site's targeted sediments. Accomplishing this design would require an iterative process of refining overall size and footprint. Enlarging the CDF provides greater storage capacity but may increase mitigation requirements and cost.

A key benefit of the CDF is its flexibility for incorporating different concepts related to environmental protection, shoreline stabilization, and land use. As such, several variations on the CDF concept envisioned by the FS (and presented on Figures 8 and 9) could be explored. Obtaining regulatory and public support for a CDF solution at the Site would very likely be facilitated by designing the CDF with additional features that improve its environmental performance and overall value to the Site. Prospective features could take many forms, including those related to the environmental benefits of the installation and related to its possible shoreline enhancement value.

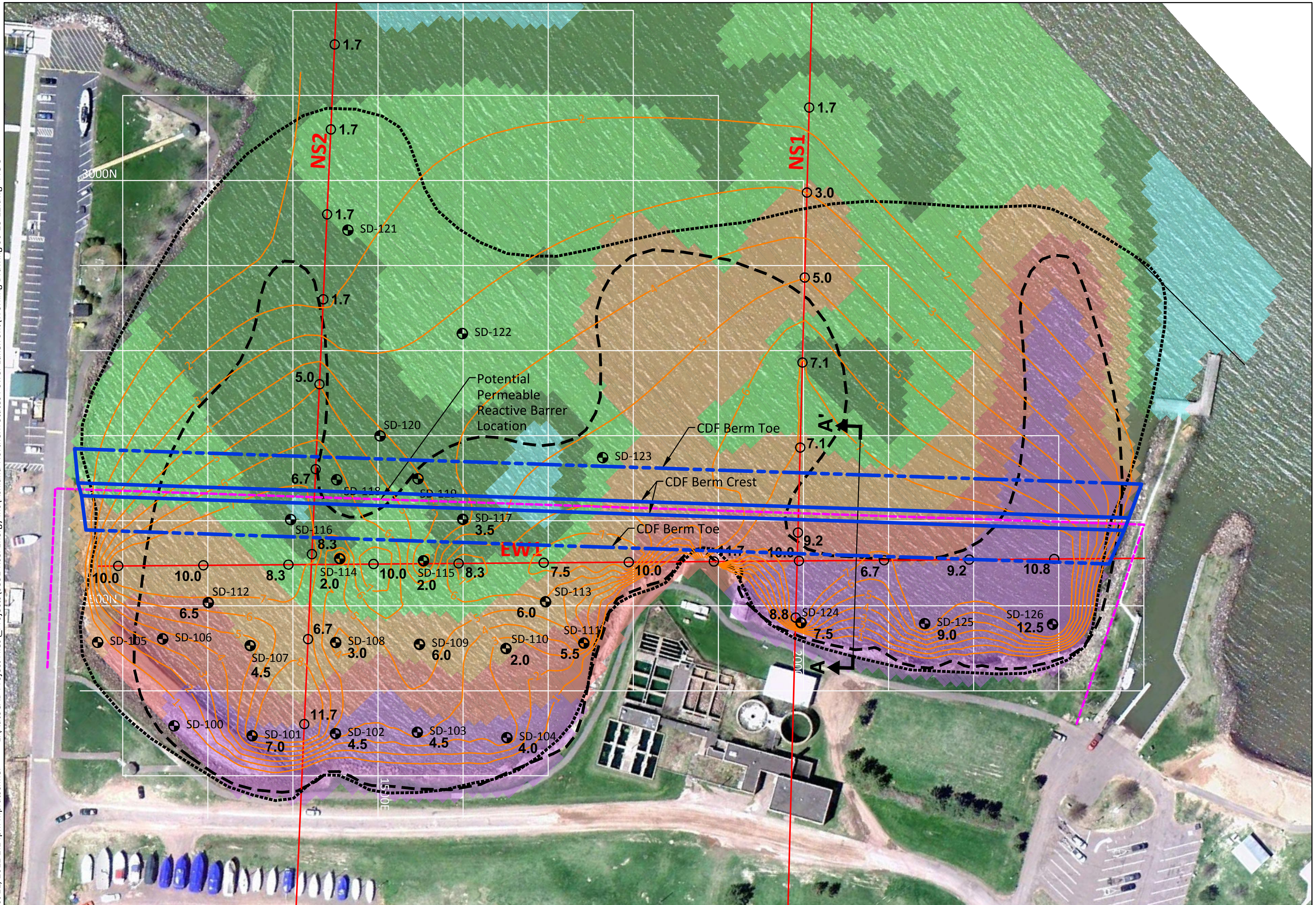
Potential concepts that would improve the environmental value of the CDF are as follows:

- The CDF could be designed with a DNAPL collection system that could effectively make it an extension of the upland Kreher Park remedy.
- If a containment berm were used to retain sediments inside the CDF, then the thickness and material grain size of the berm can be selected to enhance chemical isolation.
- In a similar fashion, the berm and/or surficial cover layers could be enhanced with an internal reactive organic carbon layer, which would augment the chemical isolation function of the facility (as conceptually shown on Figures 7 and 8 as a "permeable reactive barrier" layer).
- The CDF can be designed in tandem with accomplishing mass removal of selected sediments at the Site.

A CDF could also be designed and configured to act not only as a permanent sediment repository but also to improve or enhance the shoreline at Kreher Park. The City of Ashland's Waterfront Development Plan guides the prospective development of Ashland's waterfront in an environmentally sound and publicly accessible manner as to enhance the tourist and public potential of the area. Some ways in which the CDF could be a featured component of this plan include one or more of the following:

- By constructing all or part of the outer perimeter of the CDF as a bulkhead wall, a new vertical shoreline would be established that could be designed to accommodate access and docking by vessels and public boats. Similarly, a boat ramp could be incorporated into the CDF's geometry to augment the Prentice Avenue boat ramp at a similarly accessible point.
- The grounds of Kreher Park could be extended outward over the surface of the CDF as enhanced public space, with options to include walking paths, native plantings, and/or public education installations. The space could be designed as part of a shoreline promenade, capable of accommodating public festivals or similar gatherings; thus improving public access and use of this portion of the Chequamegon Bay shoreline.
- Because the existing usable land area at Kreher Park is limited, additional land area gained through CDF construction could be used to site a community building, educational installation, and/or recreation center.
- The CDF could be fashioned to represent a public example of industrial cleanup and environmentally sensitive remedial planning, which would dovetail with the Site's historic legacy as well as that of the adjacent existing (and refurbished) treatment plant buildings and the nearby dock.
- Some or part of the CDF surface could be built to a lower range of elevations that allow for occasional or frequent inundation by lake water and configured to provide nearshore habitat area and function. Combining this option with enhanced public access and educational exhibits would create a dramatic public example of environmental restoration and site recovery.

These, and similar, options would affect the overall cost and/or sediment capacity of the CDF but could be optimized though an iterative and integrated process of design. Altogether it is Anchor QEA's opinion that a CDF could be designed for the Site in a way that is safer, cost effective, and in full compliance with environmental protection and site restoration goals while simultaneously supporting local community redevelopment opportunities.




**SOURCES**: URS, DCI Environmental, Burns & McDonald, Sevensen Environmental Services, et al.
**HORIZONTAL DATUM**: Wisconsin County Systems, Ashland County, U.S. Feet.
**VERTICAL DATUM**: Unknown.

**LEGEND:**

- Extent of NAPL
- Extent of Contamination
- SD-125 Sediment Sampling Location and Designation
- 9 Sediment Thickness, Less Than 9.5 mg/kg TPAH in Feet
- 6 Sediment Thickness Contour in Feet
- CDF Berm
- Potential Permeable Reactive Barrier
- A A' Cross Section Location (See Figure 9 for Cross Section)

Wood Thickness (Feet)

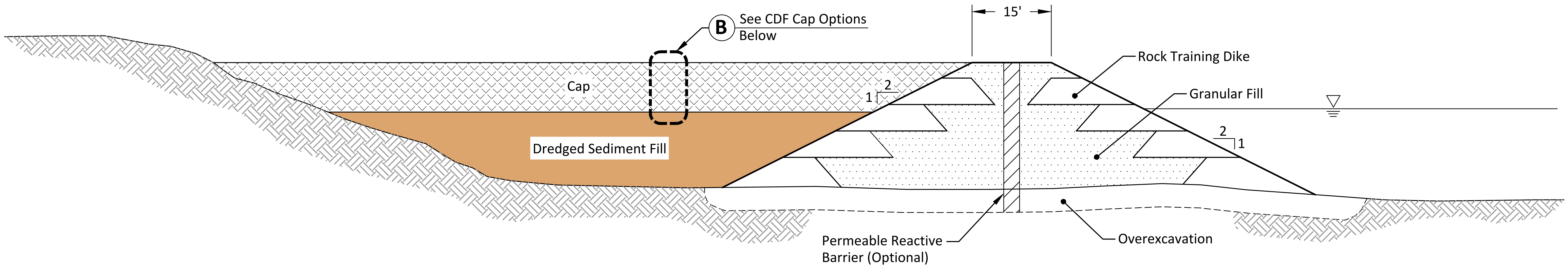
- Less than 0.1
- 0.2 - 0.5
- 0.6 - 1.0
- 1.1 - 2.0
- 2.1 - 3.0
- 3.1 - 6.0

0 120
Scale in Feet

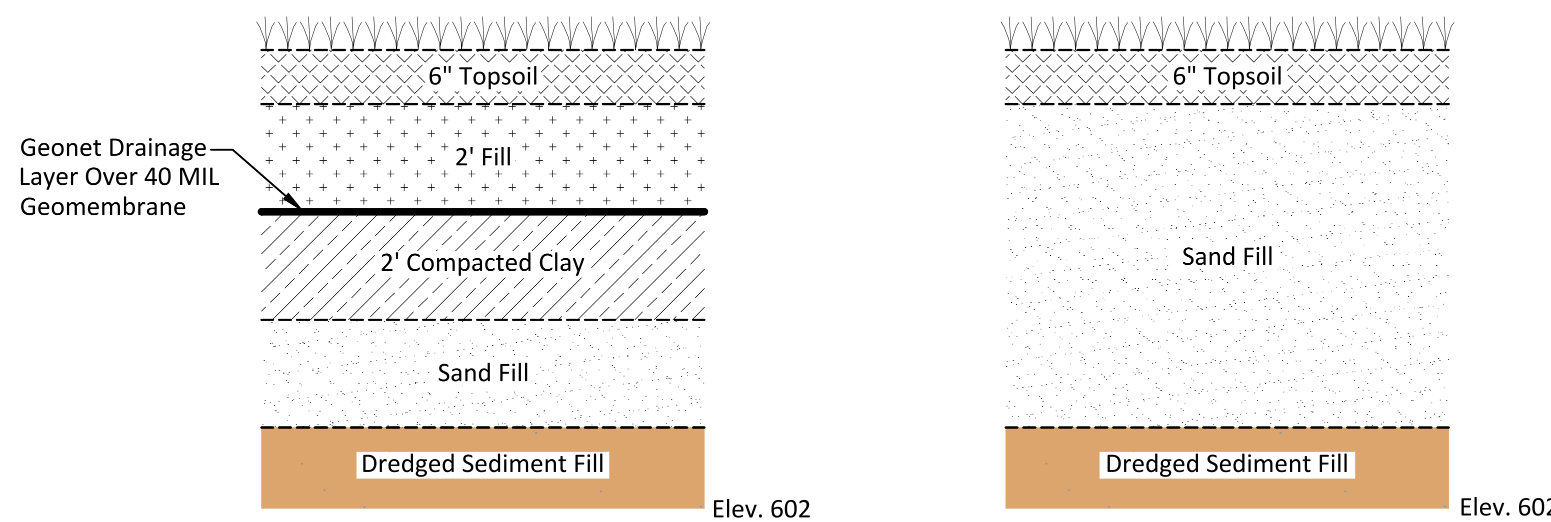


ANCHOR QEA

**Figure 8**
CDF Concept
Ashland/NSPW Lakefront Superfund Site




A/1 **SECTION**
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 1'




**Option 1**
N.T.S.

**Option 2**
N.T.S.

B **CDF Cap Options**

**HORIZONTAL DATUM**: Wisconsin County Systems, Ashland County, U.S. Feet.
**VERTICAL DATUM**: Unknown.



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**Figure 9**
Generalized Cross Section A-A'
Ashland/NSPW Lakefront Superfund Site

# 7 SUMMARY OF INDEPENDENT EVALUATION

An independent evaluation has been conducted by Anchor QEA on the technical analyses presented in the 2009 Weston Report prepared for the USEPA. Key variables and engineering parameters were selected based on a careful review of the Weston Report and site field and laboratory data available to Weston in 2009 available field and laboratory data at the time Weston published its report. In many cases, it is Anchor QEA's opinion that Weston selected parameters and engineering assumptions that are not representative of possible conditions at the Site, either in specific locations and/or at specific times.

It is important to note that when designing a critical activity (such as dry excavation) and limited design-level data is available, a range of parameters should be used, not a single averaged value. This approach helps gauge the sensitivity of the system to changes in parameters. Every engineering variable and characteristic involved—including soil properties, hydrologic data, and tidal states—necessarily have a degree of associated uncertainty and, therefore, a range of possible values. Anchor QEA recognizes that an analysis that simultaneously combines every possible "worst case" value at once could rightfully be viewed as unrealistic, because in reality, many different variables experience statistical uncertainty in which they combine in countless possible combinations. Therefore, Anchor QEA has sought to only apply variable ranges in combinations that have a realistic possibility of actually occurring at the Site in order to develop conclusions based on reasonable realistic conditions.

## 7.1 Summary of Findings

In summary, this independent evaluation presents the following conclusions:

- The generalized soil profile developed by Weston and used as the basis of its assessments does not adequately represent the possible range of conditions that have been identified by field work. The wide range of known conditions at the Site increases the uncertainty of the analyses and justifies using higher factors of safety during design elements. In particular, the stability of the excavation subgrade is very sensitive to the thickness and composition of the confining aquitard layer (the aquitard layer confines the underlying artesian groundwater head). Weston's analysis assumed a greater thickness and stronger material for the aquitard layer than may actually occur in the excavation area based on exploration data. In addition, all strength and weight parameters assigned by Weston are developed from correlations and not actually determined from laboratory testing.

- An unorthodox method was used by Weston to assess the potential for bottom upheaval (the result of upward hydrostatic pressures exceeding the weight of bottom sediments). This method was used to erroneously conclude that there is sufficient stability, while in Anchor QEA's opinion there is not.
- A dry excavation system using segments formed by individual 150-foot by 200-foot excavation cells was envisioned by Weston but is inconsistent with the approach described and evaluated in the FS and the ROD. Using smaller dry excavation cells to accomplish the work would significantly increase the time, cost, and complexity of the project while doing considerably more damage to the aquitard (through sheetpile installation and removal). It should be noted that using smaller dry excavation cells may not reach acceptable factors of safety when additional site data are gathered.
- The evaluation of sheetpile wall design indicates that sheetpiles may need to extend fully through the aquitard and into the underlying aquifer, which could permanently compromise the aquitard. However, by applying more realistic and representative soil properties (as previously described) to the analysis, in concert with expected maximum excavation depths, Anchor QEA concludes that the sheetpile wall embedment depth may extend well below the aquitard/aquifer contact depth. The full penetration of the aquitard by a sheetpile wall could permanently compromise the aquitard and result in an unnatural preferential flow pathway for water under artesian head conditions, such that groundwater could travel up to the surface and fill the wet excavation area while weakening the subgrade soils. The consequences of such an occurrence can lead to a dry excavation failure and ultimately more serious consequences that range from construction difficulties to irreparable environmental damage to potential loss of human life.

When soil conditions vary significantly between adjacent borings, as is the case at the Site, it is necessary to evaluate a range of soil profiles and properties with careful consideration of all aspects of the design under consideration. This variability increases the uncertainty and hence the risk and need for a higher factor of safety.

## 7.2 Opinion Regarding Potential Implementability of Dry Excavation

Weston proposes to mitigate the obvious dangers and challenges of the dry excavation method by subdividing the dry excavation area into separate dry excavation cells, for which they propose a size of 150 feet by 200 feet in order to raise the factor of safety against basal heave to 1.25 (note, that as stated in Section 2.4, Anchor QEA feels that a factor of safety of 1.25 is too low given all of site uncertainties and consequences of failure—a factor of safety of 1.5 is more appropriate). Using smaller dredge cells would require repeated episodes of sheetpile installation and excavation work and would have significant effects on project schedule, cost, and technical implementability and could exacerbate site conditions. These effects would be even more significant if smaller cells are necessary, as this independent evaluation suggests.

After reviewing the Weston Report, it is Anchor QEA's opinion that design-level analyses will likely be unable to adequately prove the full reliability of dry excavation, simply because there are too many variables that can never be completely quantified with precision, including:

- Hydraulic and unit weight characteristics of site sediments and the aquitard
- The full range of aquitard thickness throughout the offshore areas identified for dry excavation
- Lateral and temporal variability of artesian head levels in the aquifer
- Frequency, extents, and ramifications of localized aquitard irregularities (sand seams, cracks, and material discontinuities)
- Effects of sheetpile wall installation on the aquitard hydraulic and geotechnical properties

Implementing the dry excavation method would be incredibly onerous, costly, and risky and at best would necessitate a highly adjustable approach to the cell construction methodology in response to a host of field variables while still remaining unlikely to be appropriately robust and protective of workers and the environment. The reality of such a very unique conceptual design is that the potential for design errors, lengthy construction delays, and irreversible damage of the site conditions (i.e., disturbance of the aquitard layer) are greatly increased; all of which would otherwise be avoided with a wet dredging solution. Anchor

QEA envisions that this conceptual approach would not only be undesignable to accepted engineering standards but would also be viewed as unbiddable to the contracting community due to the associated financial and human health risk.

In Anchor QEA's opinion the unique conditions and challenges of the Site render it an extremely poor candidate for the dry excavation method—especially when the far simpler and far more demonstrated method of wet dredging remains available as well as other options such as a CDF.

In conclusion, it is Anchor QEA's opinion that that the USEPA should strongly reconsider the dry excavation approach for the Site.  This evaluation concludes that moving forward with the dry excavation system is NOT protective of human health and the environment and is ultimately unimplementable. Instead, the wet dredging and CDF alternatives are far safer and more environmentally sound options for sediment remediation at the Site.  Anchor QEA therefore recommends that the USEPA and NSPW move forward with evaluating the design and construction considerations that would apply to these alternatives.

# 8 REFERENCES


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# APPENDIX A
# CALCULATIONS

**CALCULATION COVER SHEET**

| **PROJECT:** ATC – Ashland/NSPW Lakefront Superfund Site | **CALC NO. 1** | **SHEET** 1 of 5 |
|---|---|---|
| **SUBJECT:** Reassessment of Excavation Bottom Upheaval | | |

**General**:

A reassessment of the potential for upheaval of the excavation bottom from artesian pressures (i.e. excavation bottom upheaval analysis) was performed using a more representative soil profile and soil properties than used previously by another firm. This document presents the methodology, assumptions, and calculation used for the analyses performed.

**References:**


Bowles, J. E. 1996. *Foundation Analysis and Design.* 5th ed. Chapter 14, pg 815 - 816

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**Equations:**

The equation for factor of safety (FS) against bottom blowout that is supported by the above references:

$$FS = \frac{\sum_i^n \gamma_{t,i} \cdot h_i}{\gamma_w \cdot (z_{ART} - Z_{CA})}$$

$\gamma_{t,i}$ = total unit weight of the soil unit (pcf)
$h_i$ = thickness of soil unit (ft)
$z_{ART}$ = total head of the artesian aquifer (ft; MSL)
$z_{CA}$ = elevation at the top of the confined aquifer (ft; MSL)
$\gamma_w$ = unit weight of water (62.4 pcf)

The equation for factor of safety against basal heave assumed by Weston:

$$FS = \frac{\sum_i^n \left(\gamma_{t,i} \cdot (B \cdot L) + Su_i \cdot 2(L + B)\right) \cdot h_i}{\gamma_w \cdot (z_{ART} - Z_{CA}) \cdot (B * L)}$$

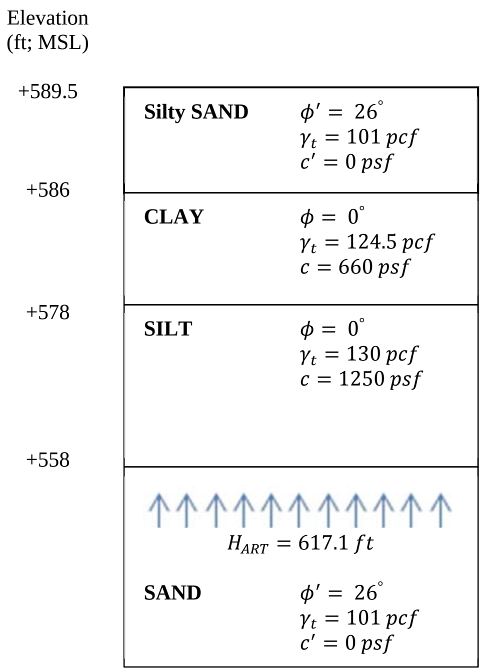
$\gamma_{t,i}$ = total unit weight of the soil unit (pcf)
$Su_i$ = undrained shear strength (psf)
$h_i$ = thickness of soil unit (ft)
$z_{ART}$ = total head of the artesian aquifer (ft; MSL)
$z_{CA}$ = elevation at the top of the confined aquifer (ft; MSL)
$\gamma_w$ = unit weight of water (62.4 pcf)
$B$ = width of excavation cell in plan view
$L$ = length of excavation cell in plan view

| CALCULATION SHEET | | | | | | SHEET 2 of 5 | |
|---|---|---|---|---|---|---|---|
| DESIGNER: | ZLK | DATE: | 05-23-12 | CALC. NO.: | 1 | REV.NO.: | 0 |
| PROJECT: | ATC – Ashland/NSPW | | | CHECKED BY: | WMM | CHECKED DATE: | 06-01-12 |
| SUBJECT: | Excavation Bottom Blowout | | | | | | |

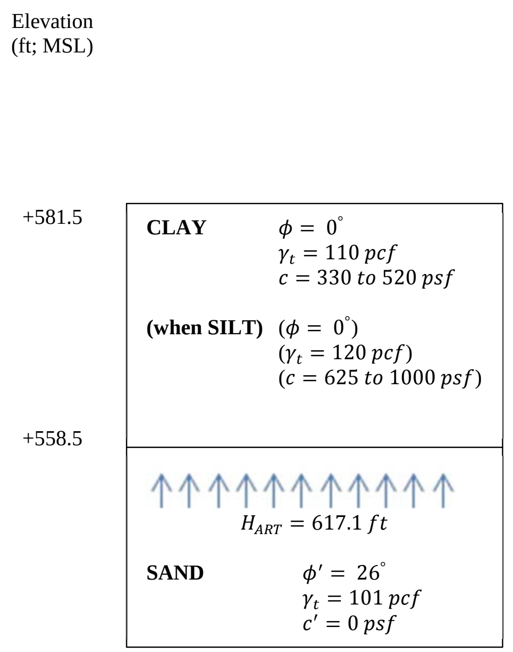
**Assumption:**

The input values for the subsequent calculations are based on the following soil profiles.

**Weston Soil Profile and Properties**




**Anchor QEA Soil Profile and Properties**




**Cases Analyzed:**

1. Reanalyzing Weston's "excavation bottom upheaval analysis" with Weston's assumed soil profile and properties, targeting a minimum FS of 1.5
2. Reanalyzing Weston's "excavation bottom upheaval analysis" with Weston's soil profile and Anchor QEA's soil properties, targeting a minimum FS of a) 1.2 and b) 1.5.
3. Completing an excavation bottom upheaval (sometimes referred to as "bottom blowout") analysis consistent with geotechnical literature, using Weston's soil profile and properties
4. Completing an excavation bottom upheaval analysis using Anchor QEA's more representative soil profile and condition-specific soil properties

Note:

For analyses that use Anchor QEA soil properties, undrained shear strength values of 460 psf and 880 psf are assumed for clay and silt, respectively. This corresponds to a 30% strength reduction of the values assumed by Weston.

**Calculations:**

Case 1:

Use Weston's assumed equation with a minimum factor of safety of 1.5 and use a trial and error approach to find appropriate excavation dimensions. For purposes of minimizing sheet pile lengths, the length to width ration (L/B) is limited to 1 < L/B < 2.

| | | | | | | | |
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| **PROJECT:** | ATC – Ashland/NSPW | | | **CHECKED BY:** | WMM | **CHECKED DATE:** | 06-01-12 |
| **SUBJECT:** | Excavation Bottom Blowout | | | | | | |

- Derive relationship for shear resistance of Silty SAND:

$$T = \int_{z_i}^{z_f} \left(k_p \cdot \sigma'_v \cdot \tan(\phi'_{SW})\right) \cdot dz$$

$T$ = total shear resistance from side friction with sheet pile wall (lb/ft)

$z$ = top elevation (feet; MSL)

$k_p$ = passive earth pressure coefficient (unitless)

$\sigma'_v$ = effective vertical overburden (psf; $f(z)$)

$\phi'_{SW}$ = effective friction angle between soil and sheetpile wall (deg)

For $k_p$:

$$k_p = tan^2\left(45^\circ + \frac{\phi'_{SM}}{2}\right) \rightarrow k_p = tan^2\left(45^\circ + \frac{26}{2}\right) \rightarrow k_p = 2.6$$

For $\sigma'_v$:

$$\sigma'_v = (\gamma_t - \gamma_w) \cdot z \rightarrow \sigma'_v = (101 - 62.4) \cdot z \rightarrow \sigma'_v = 38.6 \cdot z \text{ (i.e., } f(z))$$

For $\phi'_{SW}$:

$$\sigma'_{SW} = \frac{2}{3} \cdot \sigma'_{SM} \rightarrow \sigma'_{SW} = \frac{2}{3} \cdot 26^\circ \rightarrow \sigma'_{SW} = 17.3^\circ$$

For $T$:

$$T = \int_{z_i}^{z_f} \left(k_p \cdot \sigma'_v \cdot \tan(\phi'_{SW})\right) \cdot dz \rightarrow T = \int_{586}^{589.5} (2.6) \cdot (38.6 \cdot z) \cdot \tan(17.3) \cdot dz \rightarrow T = 191 \text{ lb/ft}$$

Note: For purposes of maintaining consistent units with the parameter for undrained shear strength, the parameter $T$ is represented as an average uniformly distributed soil shear strength in the analyses below, which is $T$ divided by the layer thickness (i.e., $191/3.5 = 54.6\,psf$).

- Use Weston's equation to find appropriate excavation dimensions.

$$FS = \frac{\sum_i^n \left(\gamma_{t,i} \cdot (B \cdot L) + Su_i \cdot 2(L+B)\right) \cdot h_i}{\gamma_w \cdot (z_{ART} - Z_{CA}) \cdot (B * L)} \rightarrow 1.5 = \frac{\left((101) \cdot (B \cdot L) + 54.6 \cdot 2 \cdot (L+B)\right) \cdot 3.5 + \left((124.5) \cdot (B*L) + 660 \cdot 2 \cdot (B+L)\right) \cdot 8 + \left((130) \cdot (B*L) + 1250 \cdot 2 \cdot (B+L)\right) \cdot 20}{62.4 \cdot (617.1 - 558) \cdot (B*L)} \rightarrow$$

Use spreadsheet for trial and error (i.e. EXCEL) → $\boldsymbol{L_{MAX} = 100\,ft}$ **and** $\boldsymbol{B_{MAX} = 65\,ft}$; $\frac{L_{MAX}}{B_{MAX}} = 1.54$ ∴ OKAY

Case 2a and 2b:

Use Weston's assumed equation with a minimum factor of safety of 1.2 and 1.5 and use a trial and error approach to find appropriate excavation dimensions. For purposes of minimizing sheet pile lengths, the length to width ration (L/B) is limited to 1 < L/B < 2.

- Use previously derived relationship for shear resistance of Silty SAND:

  $T = 191\ lb/ft$

- Use Weston's equation to find appropriate excavation dimensions.

  a):

$$FS = \frac{\sum_i^n \left(\gamma_{t,i} \cdot (B \cdot L) + Su_i \cdot 2(L+B)\right) \cdot h_i}{\gamma_w \cdot (z_{ART} - Z_{CA}) \cdot (B * L)} \rightarrow 1.2 = \frac{\left((101) \cdot (B \cdot L) + 54.6 \cdot 2 \cdot (L+B)\right) \cdot 3.5 + \left((110) \cdot (B*L) + 460 \cdot 2 \cdot (B+L)\right) \cdot 8 + \left((120) \cdot (B*L) + 880 \cdot 2 \cdot (B+L)\right) \cdot 20}{62.4 \cdot (617.1 - 558) \cdot (B*L)} \rightarrow$$

Use spreadsheet for trial and error (i.e. EXCEL) → $\boldsymbol{L_{MAX} = 120\,ft}$ **and** $\boldsymbol{B_{MAX} = 100\,ft}$; $\frac{L_{MAX}}{B_{MAX}} = 1.20$ ∴ OKAY

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b):

$$FS = \frac{\sum_i^n \left(\gamma_{t,i}\cdot(B\cdot L) + Su_i\cdot 2(L+B)\right)\cdot h_i}{\gamma_W\cdot(z_{ART}-Z_{CA})\cdot(B*L)} \rightarrow 1.5 = \frac{\left((101)\cdot(B\cdot L)+54.6\cdot 2\cdot(L+B)\right)\cdot 3.5+\left((110)\cdot(B*L)+460\cdot 2\cdot(B+L)\right)\cdot 8+\left((120)\cdot(B*L)+880\cdot 2\cdot(B+L)\right)\cdot 20}{62.4\cdot(617.1-558)\cdot(B*L)}$$

Use spreadsheet for trial and error (i.e. EXCEL) → $\boldsymbol{L_{MAX} = 65\ ft}$ **and** $\boldsymbol{B_{MAX} = 35\ ft}$; $\frac{L_{MAX}}{B_{MAX}} = 1.86$ ∴ OKAY

Case 3:

Use the literary supported equation for bottom blowout to find the factor of safety.

$$FS = \frac{\sum_i^n \gamma_{t,i}\cdot h_i}{\gamma_W\cdot(z_{ART}-Z_{CA})} \rightarrow FS = \frac{101\cdot 3.5+124.5\cdot 8+130\cdot 20}{62.4\cdot(617.1-558)} \rightarrow FS = 1.08$$

Anchor QEA's assumed $FS_{MIN} = 1.5$

Weston's assumed $FS_{MIN} = 1.2$

∴ **Neither safety standard is satisfied**

Case 4:

Use the literary supported equation for bottom blowout to find the factor of safety.

$$FS = \frac{\sum_i^n \gamma_{t,i}\cdot h_i}{\gamma_W\cdot(z_{ART}-Z_{CA})} \rightarrow FS = \frac{110\cdot 23}{62.4\cdot(617.1-558.5)} \rightarrow FS = 0.69$$

Anchor QEA's assumed $FS_{MIN} = 1.5$

Weston's assumed $FS_{MIN} = 1.2$

∴ **Neither safety standard is satisfied and failure is predicted**

**Summary:**

The cell dimensions determined using Weston's equation are highly dependent on the minimum factor of safety and thickness of the clay and silt assumed. The soil unit weight and undrained shear strength of clay and silt influence the size but to a lesser degree. For the literary supported equation, safety standards are not satisfied and for the more conservative case 4, failure is indicated.

| Cases | Cell Dimensions (Length x Width; feet) | Percent Area of a 150 feet x 200 feet Cell | Factor of Safety |
|---|---|---|---|
| 1 | 100 x 65 | 22% | ≥ 1.5 |
| 2a | 120 x 100 | 40% | ≥ 1.2 |
| 2b | 65 x 35 | 7.6% | ≥ 1.5 |
| 3 | N/A | N/A | 1.08 |
| 4 | N/A | N/A | 0.69 |

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| **PROJECT:** | ATC – Ashland/NSPW | | | **CHECKED BY:** | WMM | **CHECKED DATE:** | 06-01-12 |
| **SUBJECT:** | Excavation Bottom Blowout | | | | | | |

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**CALCULATION COVER SHEET**

| **PROJECT:** ATC – Ashland/NSPW Lakefront Superfund Site | **CALC NO. 2** | **SHEET** 1 of 7 |
|---|---|---|
| **SUBJECT:** Reassessment of Basal Heave Shear Instability | | |

**General**:

A reassessment of the potential for basal heave shear instability of the excavation bottom as caused by the retained soil load, and free water and artesian pressures was performed through several analyses using a more conservative soil profile and soil properties than used previously by another firm. This document presents the methodology, assumptions, and calculation used for the analyses performed.

**References:**


Naval Facilities Engineering Command (1986). "Foundation and Earth Structures: Design Manual 7.2." *NAVFAC DM-7.2*. Department of the Navy. September 1986.

Fang, H-Y, 1991. *Foundation Engineering Handbook*.

ASCE. 1997. *Geotechnical Special Publication No. 74: Guidelines of Engineering Practice For Braced and Tied-Back Excavations*. Authored by Committee on Earth Retaining Structures of The Geo-Institute of The American Society of Civil Engineers.

Bray, J.D., 2011. Personal Communication. Lecture Notes for CE 277: Advanced Foundation Engineering. University of California, Berkeley. Spring 2011.


**Equations:**

The equation for factor of safety against basal heave that is assumed:

$$FS_{BH} = \frac{S_{u,1} \cdot (N_{c,s} \cdot f_d \cdot f_s)}{\gamma \cdot h + q}$$

Where,

$FS_{BH}$ = factor of safety against basal heave
$N_{c,s}$ = bearing capacity factor that is independent of excavation depth (unitless)
$S_{u,1}$ = undrained shear strength of upper clay (psf)
$\gamma$ = total unit weight of outward soil (pcf)
$h$ = depth of excavation (ft)
$q$ = surcharge pressure from free water and artesian pressure (psf)
$f_d$ = depth correction factor; function of excavation depth and width (unitless)
$f_s$ = shape correction factor; function of excavation width and length (unitless)

The excavation dimensions for width (B) and length (L) are used with the depth from the excavation bottom to the stiff stratum (T) and excavation depth (h) to determine $N_{c,s} \cdot f_d \cdot f_s$ from the charts in the Appendix. The charts are adapted from NAVFAC DM - 7.2.

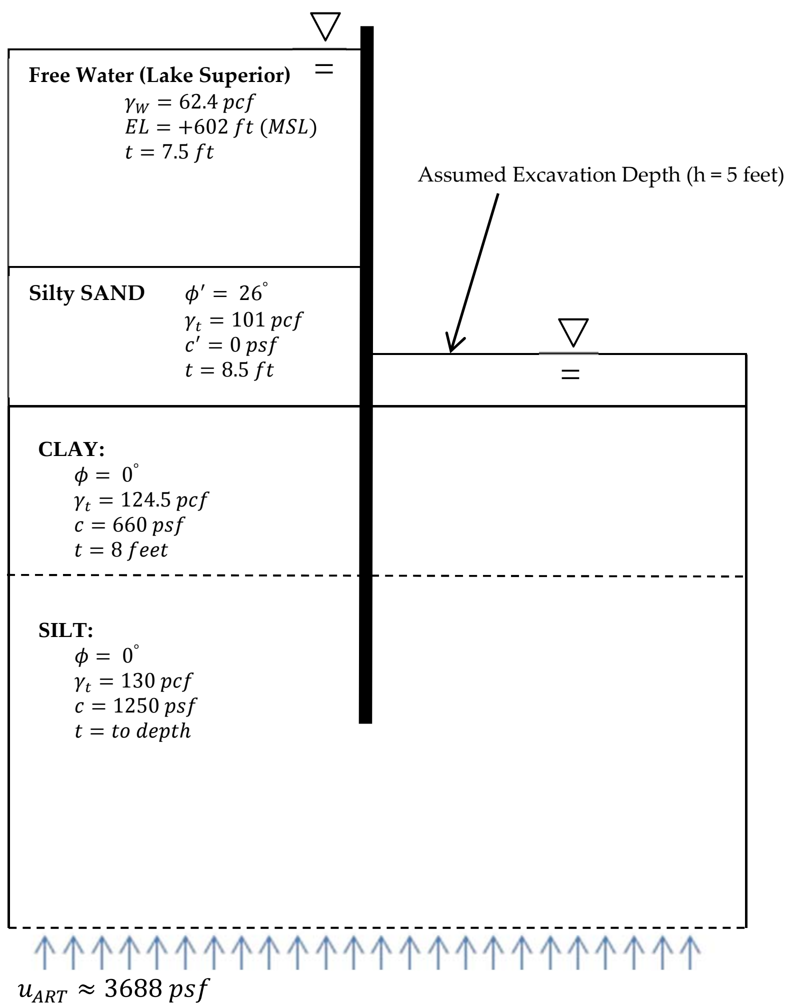
**Assumption:**

In applying the above method Weston made two key assumptions, which for analyses purposes are adopted:

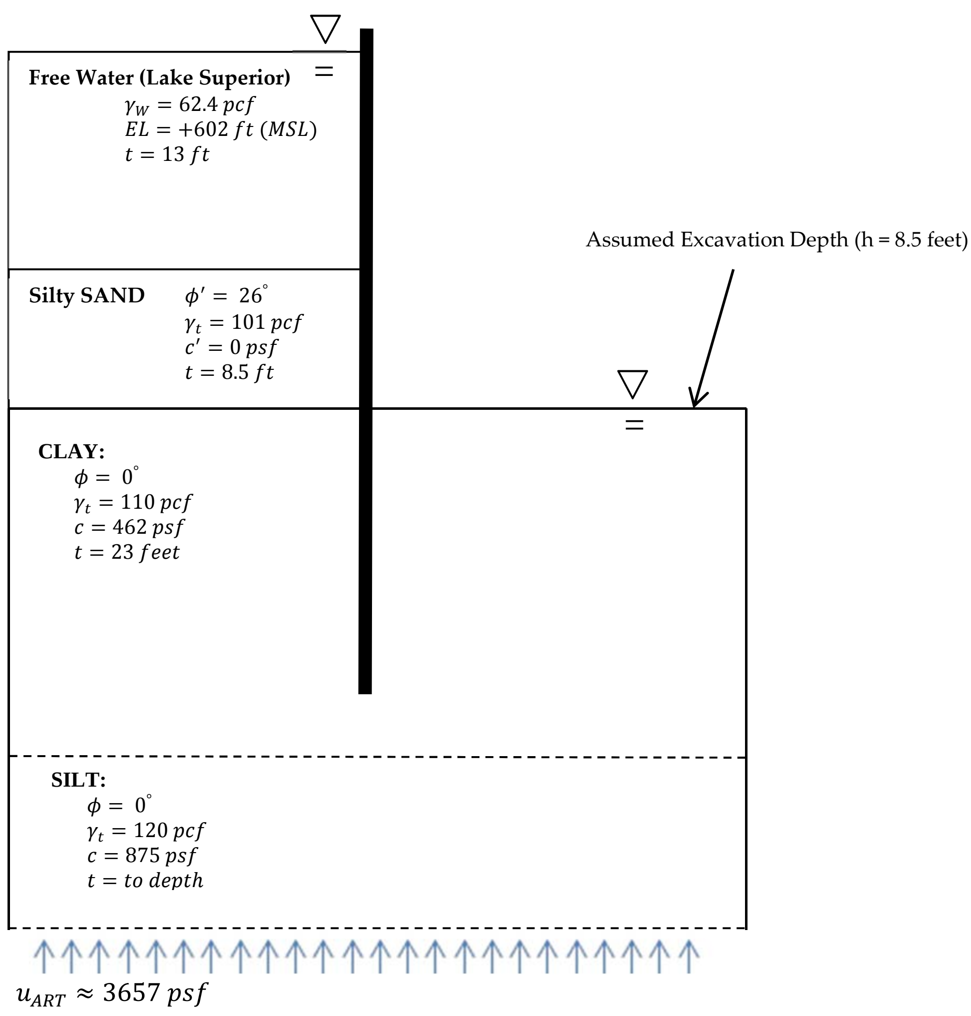
- To include the additional driving force from the artesian aquifer, Weston models the artesian pressure that acts at the base of the aquatard as an additional surcharge load.
- The silt must be very thick (i.e. thicker than assumed in their profile) for their basal heave analysis to be consistent with published literature. Therefore, the aquifer and silt layers are treated as if they have similar shear strengths and behavior in response to the loading conditions.

The input values for the subsequent calculations are based on the soil profiles shown:

**<u>Weston's Soil Profile and Scenario Assumed by Weston and Properties</u>**



**Anchor QEA's Soil ProRepresentative Soil Profile and Scenario Assumed by Anchor QEAfile and Properties**




**Analyses:**

The following analyses were performed for Weston's 150 by 200 foot dry excavation cell:

1. Reanalysis using Weston's soil profile and properties.
2. Reanalysis using Weston's soil profile and Anchor QEA's soil properties.
3. Reanalysis using Anchor QEA's soil profile and Anchor QEA's soil properties.

4. Back analysis to determine dimensions required for a factor of safety of 1.5 assuming Anchor QEA soil profile and properties.

**Calculations:**

For 1: Use Weston's soil profile and properties

From Figure 5 from Chapter 4 of NAVFAC DM 7.2 to determine $N_{c,s}$ , $f_d$ for the three excavation designs (A,B,C):

$c_2/c_1 = 1250/660 = 1.89$

$T/B = 11.5/150 = 0.077$

$\therefore N_{c,s} \approx 10$

$D/B = 5/150 = 0.033$

*linearly interpolate chart titles "Effect of D": $f_d = 1 + \frac{0.033}{0.50} \cdot 0.15$

$\therefore f_d \approx 1.01$

$f_s = 1 + 0.2 * \frac{B}{L}; B = 150\ ft, L = 200\ ft$

$\therefore f_s = 1.15$

$FS_{BH} = \frac{c_1 \cdot (N_{c,s} \cdot f_d \cdot f_s)}{\gamma \cdot h + q} \rightarrow FS_{BH} = \frac{660 \cdot (10 \cdot 1.01 \cdot 1.15)}{101 \cdot 5 + 13 \cdot 62.4 + 3688} \rightarrow \boldsymbol{FS_{BH} = 1.63}$

For 2: Use Weston's soil profile and Anchor QEA's soil properties

From Figure 5 from Chapter 4 of NAVFAC DM 7.2 to determine $N_{c,s}$ , $f_d$ for the three excavation designs (A,B,C):

$c_2/c_1 = 875/462 = 1.89$

$T/B = 11.5/150 = 0.077$

$\therefore N_{c,s} \approx 10$

$D/B = 5/150 = 0.033$

*linearly interpolate chart titles "Effect of D": $f_d = 1 + \frac{0.033}{0.50} \cdot 0.15$

$\therefore f_d \approx 1.01$

$f_s = 1 + 0.2 * \frac{B}{L}; B = 150\ ft, L = 200\ ft$

$\therefore f_s = 1.15$

$FS_{BH} = \frac{c_1 \cdot (N_{c,s} \cdot f_d \cdot f_s)}{\gamma \cdot h + q} \rightarrow FS_{BH} = \frac{462 \cdot (10 \cdot 1.01 \cdot 1.15)}{101 \cdot 5 + 13 \cdot 62.4 + 3688} \rightarrow \boldsymbol{FS_{BH} = 1.15}$

For 3: Using Anchor QEA's soil profile and soil properties

From Figure 5 from Chapter 4 of NAVFAC DM 7.2 to determine $N_{c,s}$ , $f_d$ for the three excavation designs (A,B,C):

$^{c_2}/_{c_1} = {}^{875}/_{462} = 1.89$

$^{T}/_{B} = {}^{23}/_{150} = 0.153$

$\therefore N_{c,s} \approx 9.4$

$^{D}/_{B} = {}^{8.5}/_{150} = 0.057$

*linearly interpolate chart titles "Effect of D": $f_d = 1 + \frac{0.057}{0.50} \cdot 0.15$

$\therefore f_d \approx 1.017$

$f_s = 1 + 0.2 * \frac{B}{L}; B = 150\ ft, L = 200\ ft$

$\therefore f_s = 1.15$

$FS_{BH} = \frac{c_1 \cdot (N_{c,s} \cdot f_d \cdot f_s)}{\gamma \cdot h + q} \rightarrow FS_{BH} = \frac{462 \cdot (9.4 \cdot 1.017 \cdot 1.15)}{101 \cdot 8.5 + 13 \cdot 62.4 + 3657} \rightarrow \boldsymbol{FS_{BH} = 0.95}$

For 4: Back analyze for dimensions for a factor of safety of 1.5 with Anchor QEA soil profile and properties

Solve for $(N_{c,s} \cdot f_d \cdot f_s)$

$(N_{c,s} \cdot f_d \cdot f_s) = \frac{1.5 \cdot (\gamma \cdot h + q)}{c_1} \rightarrow (N_{c,s} \cdot f_d \cdot f_s) = \frac{1.5 \cdot (101 \cdot 8.5 + 13 \cdot 62.4 + 3657)}{462} \rightarrow (N_{c,s} \cdot f_d \cdot f_s) = 17.3$

Try Max $N_{c,s}$ and $f_s$:

$N_{c,s,MAX} = 10;\ \therefore {}^{T}/_{B} = 0.1 \rightarrow B = 0.1 \cdot 2 = 230\ ft;\ {}^{D}/_{B} = {}^{8.5}/_{230} = 0.037$

$f_{s,MAX} = 1 + 0.2\frac{B=L}{B=L} \rightarrow f_{s,MAX} = 1.2$

*linearly interpolate chart titles "Effect of D": $f_d = 1 + \frac{0.037}{0.50} \cdot 0.15$

$\therefore f_d \approx 1.011$

$(N_{c,s,MAX} \cdot f_d \cdot f_{s,MAX}) = 10 \cdot 1.2 \cdot 1.011 = 12.12$

$\mathbf{12.12} < 17.3\ \therefore Dimensions\ cannot\ be\ found.\ Must\ reduced\ q\ (i.e., artesian\ pressure)$

**Summary:**

In only one analysis was the factor of safety higher than 1.5 (recommended by NAVFAC, Fang, and Bowles) – Weston's design, soil profiles and parameters. Subscribing to the notation that Weston's assumptions are valid, the 150 by 200 foot cell does not meet minimum performance standards for all site conditions. The high degree of variability of the site conditions suggests that further analysis is required and that the feasibility of dry excavation has not been suitably demonstrated by Weston's analysis.

| Analysis | Factor of Safety | Comment |
|---|---|---|
| 1 | 1.63 | This result is consistent with Weston's analysis |
| 2 | 1.15 | Comparing with analysis 1, the result demonstrate that the potential for basal heave is most sensitive to the undrained shear strength of the upper clay layer |
| 3 | 0.95 | The results demonstrate that a combined effect of a reduced undrained shear strength and a thickened upper clay layer results in substantial susceptibility for basal heave. |

| | | |
|---|---|---|
| 4 | N/A | The driving stresses from the surcharge pressure are large enough such that the required bearing capacity factor to satisfy a factor of safety of 1.5 could not be achieved. Therefore, cell dimensions that result in a factor of safety of 1.5 against basal heave cannot be designed for the soil profile and properties assumed. |

**Appendix: NAVFAC Charts**

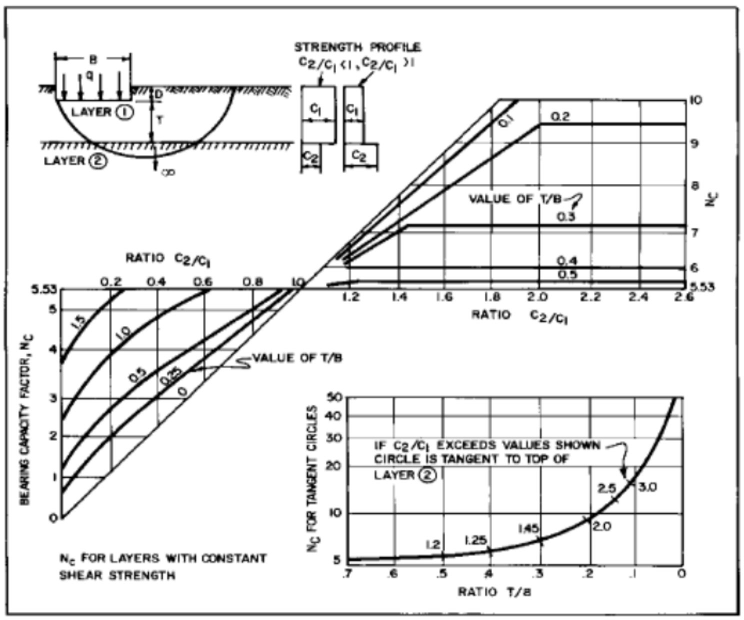



FIGURE 5
Ultimate Bearing Capacity of Two Layer Cohesive Soil (Ø=0)

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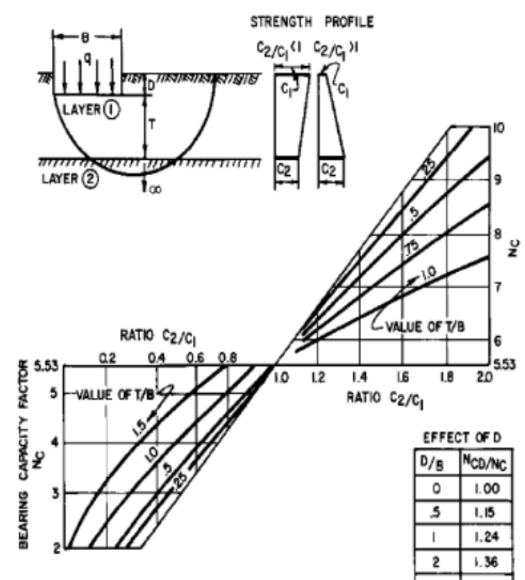
| PROJECT: | ATC – Ashland/NSPW | | | CHECKED BY: | WMM | CHECKED DATE: | 06-07-12 |
| SUBJECT: | Basal Heave | | | | | | |




| D/B | $N_{CD}/N_C$ |
|---|---|
| 0 | 1.00 |
| .5 | 1.15 |
| 1 | 1.24 |
| 2 | 1.36 |
| 3 | 1.43 |
| 4 | 1.46 |

LEGEND

D = DEPTH OF EMBEDMENT OF FOOTING
$N_C$ = BEARING CAPACITY FACTOR FOR CONTINUOUS FOOTING WITH D=0
$N_{CD}$ = FACTOR FOR CONTINUOUS FOOTING WITH D >0
$N_{CR}$ = FACTOR FOR RECTANGULAR FOOTING WITH D=0

CONTINUOUS FOOTING

$q_{ult} = c_1 N_{CD} + \gamma D$

$N_{CD}/N_C$ FROM TABLE ABOVE

RECTANGULAR FOOTING

$N_{CR} = N_{CD}\left[1+0.2\left(\frac{B}{L}\right)\right]$, $q_{ult} = c_1 N_{CR} + \gamma D$

FIGURE 5 (continued)
Ultimate Bearing Capacity of Two Layer Cohesive Soil ($\emptyset$=0)

## RECORD OF REVISIONS

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| **PROJECT:** | ATC – Ashland/NSPW | | | **CHECKED BY:** | WMM | **CHECKED DATE:** | 06-07-12 |
| **SUBJECT:** | Basal Heave | | | | | | |

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## CALCULATION COVER SHEET

| PROJECT: Ashland/NSPW Lakefront Superfund Site | CALC NO. 3 | SHEET 1 of 5 |
| --- | --- | --- |
| SUBJECT: Reassessment of Minimum Sheetpile Embedment | | |

**General**:

The below analysis was performed to check if sheetpile embedment for a cantilevered retaining wall would penetrate the aquitard. Conditions for stability are only equilibrium of horizontal forces and moments about the sheetpile toe (i.e., the sheetpile is a rigid body and a free-earth support is assumed at the tip). This method of analysis produces shallower embedment depths than an analysis that assumes a fixed earth support at tip, and hence the analysis would be a best case scenario for sheetpile embedment in terms of avoiding penetration through the aquatard. Analysis of maximum moment developed in sheetpile and allowable deflections would be needed for sheetpile material selection, and would be conducted by a structural engineer.

**References:**


United States Steel and Federal Highway Administration (1984). "Steel Sheet Piling Design Manual." July 1984

Naval Facilities Engineering Command (1986). "Foundation and Earth Structures: Design Manual 7.2." *NAVFAC DM-7.2*. Department of the Navy. September 1986.

Bray, J.D., 2011. Personal Communication. Lecture Notes for CE 277: Advanced Foundation Engineering. University of California, Berkeley. Spring 2011.


**Equations:**

For horizontal force equilibrium:

$$FS = \frac{\sum horizontal\ forces\ from\ passive\ pressures}{\sum horizontal\ forces\ from\ active\ pressures}$$

For moment equilibrium:

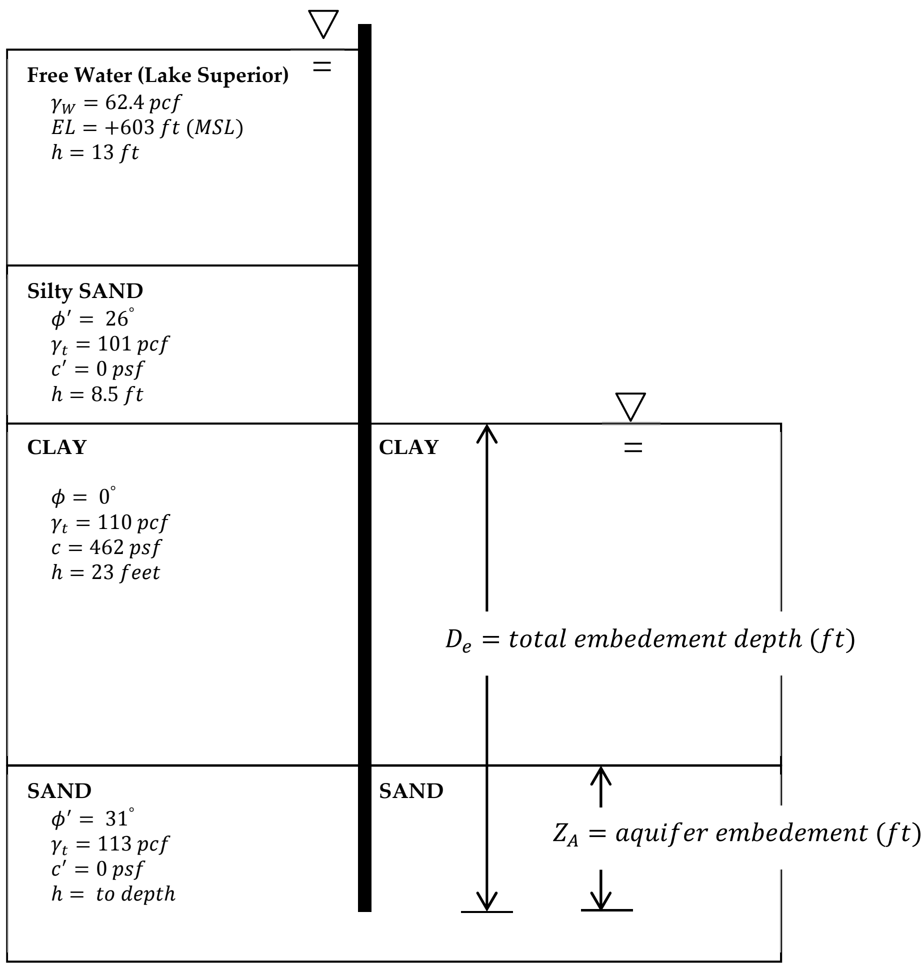
$$FS = \frac{\sum moments\ from\ passive\ pressures}{\sum moments\ from\ active\ pressures}$$

Where moments are taken about the sheetpile tip.

**Assumptions:**

- Forces from wind and ice are not considered
- The earth support at the tip of the sheetpile is assumed to be free (i.e., rotate).
- Rankine earth pressure theory is assumed for active and passive pressures
- Artesian pressures are not considered when estimates earth pressures. The pore water pressure is assumed to be hydrostatic with the head water and tail water for the active and passive earth pressures, respectively.
- Calculations are based on the soil profile and properties developed by Anchor QEA (see Calculation Sheet No. 1). A diagram of the load conditions are presented:

**Anchor QEA Soil Profile and Properties**




**Scenarios Analyzed:**

1. Determine total depth of embedment ($D_e$) and aquifer embedment($Z_A$) for FS = 1.3
2. Determine total depth of embedment ($D_e$) and aquifer embedment($Z_A$) for FS = 1.5

**Calculations:**

Determine resultant forces for earth pressure prisms

For Active Pressures:

- $F_W = resultant\ force\ for\ hydrostatic\ presure\ from\ Free\ Water$
  $F_W = \frac{1}{2} \cdot \gamma_w \cdot {h_w}^2 \rightarrow F_W = \frac{1}{2} \cdot 62.4 \cdot (13 + 8.5)^2 = \mathbf{14,400\ lb/ft}$
  → Force acts 30.17 + $Z_A\ (ft)$ from the base

- $P_{A,SS} = resultant\ force\ for\ active\ earth\ pressure\ of\ Silty\ SAND$

  $P_{A,SS} = \frac{1}{2} \cdot K_a \cdot \gamma_{b\_SS} \cdot h_{SS}^2$ → $P_{A,SS} = \frac{1}{2} \cdot \left(tan^2\left(45^\circ - \frac{26^\circ}{2}\right)\right) \cdot (101 - 62.4) \cdot 8.5^2 = \mathbf{540\ lb/ft}$

  → Force acts 25.83 + $Z_A\ (ft)$ from the base

- $P_{A,CLAY,1} = resultant\ force\ for\ active\ earth\ pressure\ of\ CLAY\ from\ Silty\ SAND\ overburden$

  $P_{A,CLAY,1} = K_{SOFT\ CLAY} \cdot (\gamma_{b\_SS} \cdot h_{SS}) \cdot h_{CLAY}$ → $P_{A,CLAY,1} = 0.6 \cdot (101 - 62.4) \cdot (8.5) \cdot 23 = \mathbf{4,500\ lb/ft}$

  → Force acts 11.5 + $Z_A\ (ft)$ from the base

- $P_{A,CLAY,2} = resultant\ force\ for\ active\ earth\ pressure\ of\ CLAY$

  $P_{A,CLAY,2} = \frac{1}{2} \cdot \gamma_{eq,design} \cdot h_{CLAY}^2$ → $P_{A,CLAY,2} = \frac{1}{2} \cdot 70 \cdot 23^2 = \mathbf{18,500\ lb/ft}$

  → Force acts 7.70 + $Z_A\ (ft)$ from the base

- $P_{A,SAND,1} = resultant\ force\ for\ active\ earth\ pressure\ of\ SAND\ \ (i.e., aquifer) from\ overburden$

  $P_{A,SAND,1} = K_a \cdot (\gamma_{b,ss} \cdot h_{ss} + \gamma_{b,CLAY} \cdot h_{CLAY}) \cdot h_{SAND}$ → $P_{A,SAND,1} = \left(tan^2\left(45^\circ - \frac{31^\circ}{2}\right)\right) \cdot (113 \cdot 8.5 + 110 \cdot 23 - 62.4 \cdot 31.5) \cdot Z_A = \mathbf{460 \cdot Z_A\ lb/ft}$

  → Force acts $\frac{1}{2} \cdot Z_A\ (ft)$ from the base

- $P_{A,SAND,2} = resultant\ force\ for\ active\ earth\ pressure\ of\ SAND\ \ (i.e., aquifer)$

  $P_{A,SAND,2} = \frac{1}{2} \cdot K_a \cdot \gamma_{b\_SAND} \cdot h_{SAND}^2$ → $P_{A,SAND,2} = \frac{1}{2} \cdot \left(tan^2\left(45^\circ - \frac{31^\circ}{2}\right)\right) \cdot (113 - 62.4) \cdot Z_A^2 = \mathbf{9 \cdot {Z_A}^2\ lb/ft}$

  → Force acts $\frac{1}{3} \cdot Z_A\ (ft)$ from the base

For Passive Pressures:

- $P_{A,CLAY,1} = resultant\ force\ for\ active\ earth\ pressure\ of\ CLAY$

  $P_{A,CLAY,1} = \frac{1}{2} \cdot \left((\sigma_{v,TOP} + 2 \cdot S_{u,CLAY}) + (\sigma_{v,BOT} + 2 \cdot S_{u,CLAY})\right) \cdot h_{CLAY}$ → $P_{A,CLAY,1} = \frac{1}{2} \cdot \left((0 + 2 \cdot 462) + (110 \cdot 23 + 2 \cdot 462)\right) \cdot 23 = \mathbf{50,800\ lb/ft}$

  → Force acts 9.3 + $Z_A\ (ft)$ from the base

- $P_{A,SAND,1} = resultant\ force\ for\ active\ earth\ pressure\ of\ SAND\ \ (i.e., aquifer) from\ overburden$

  $P_{A,SAND,1} = K_p \cdot (\gamma_{b,CLAY} \cdot h_{CLAY}) \cdot h_{SAND}$ → $P_{A,SAND,1} = \left(tan^2\left(45^\circ + \frac{31^\circ}{2}\right)\right) \cdot (110 \cdot 23 - 62.4 \cdot 23) \cdot Z_A = \mathbf{3,416 \cdot Z_A\ lb/ft}$

  → Force acts $\frac{1}{2} \cdot Z_A\ (ft)$ from the base

- $P_{A,SAND,2} = resultant\ force\ for\ active\ earth\ pressure\ of\ SAND\ \ (i.e., aquifer)$

  $P_{A,SAND,2} = \frac{1}{2} \cdot K_p \cdot \gamma_{b\_SAND} \cdot h_{SAND}^2$ → $P_{A,SAND,2} = \frac{1}{2} \cdot \left(tan^2\left(45^\circ + \frac{31^\circ}{2}\right)\right) \cdot (113 - 62.4) \cdot Z_A^2 = \mathbf{80 \cdot {Z_A}^2\ lb/ft}$

  → Force acts $\frac{1}{3} \cdot Z_A\ (ft)$ from the base

Check horizontal force equilibrium above aquifer:

$Z_A > 0\ if\ \sum horizontal\ forces\ from\ passive\ side\ < \sum horizontal\ forces\ from\ active\ side$

$(50{,}800) < (14{,}400 + 540 + 4{,}500 + 18{,}500) \rightarrow 50{,}800\ \not< 37{,}940$
$\therefore Not\ conclusive, check\ moments$

Check moments above aquifer:

$Z_A > 0\ if\ \sum moments\ from\ passive\ side\ < \sum moments\ from\ active\ side$

$(50{,}800 \cdot 9.3) < (14{,}400 \cdot 30.17 + 540 \cdot 25.83 + 4{,}500 \cdot 11.5 + 18{,}500 \cdot 7.70) \rightarrow 472{,}440 < 642{,}596$
$\therefore Embedment\ will\ be\ into\ aquifer$

Check total and aquifer embedment for FS =1.3:

$$1.3 = \frac{\sum moments\ from\ passive\ pressures}{\sum moments\ from\ active\ pressures}$$

$$1.3 = \frac{50{,}800 \cdot (9.3 + Z_A) + \frac{1}{2} \cdot 3{,}416 \cdot Z_A{}^2 + \frac{1}{3} \cdot 80 \cdot Z_A{}^3}{14{,}400 \cdot (30.17 + Z_A) + 540 \cdot (25.83 + Z_A) + 4{,}500 \cdot (11.5 + Z_A) + 18{,}500 \cdot (7.70 + Z_A) + \frac{1}{2} \cdot 460 \cdot Z_A{}^2 + \frac{1}{3} \cdot 9 \cdot Z_A{}^3}$$

→ Use EXCEL with trial and error to obtain $Z_A$
$\boldsymbol{Z_A = 14.0\ ft}$
$\boldsymbol{D_e = 37.0\ ft}$

Check total and aquifer embedment for FS =1.5:

$$1.5 = \frac{\sum moments\ from\ passive\ pressures}{\sum moments\ from\ active\ pressures}$$

$$1.5 = \frac{50{,}800 \cdot (9.3 + Z_A) + \frac{1}{2} \cdot 3{,}416 \cdot Z_A{}^2 + \frac{1}{3} \cdot 80 \cdot Z_A{}^3}{14{,}400 \cdot (30.17 + Z_A) + 540 \cdot (25.83 + Z_A) + 4{,}500 \cdot (11.5 + Z_A) + 18{,}500 \cdot (7.70 + Z_A) + \frac{1}{2} \cdot 460 \cdot Z_A{}^2 + \frac{1}{3} \cdot 9 \cdot Z_A{}^3}$$

→ Use EXCEL( with trial and error to obtain $Z_A$
$\boldsymbol{Z_A = 18.5\ ft}$
$\boldsymbol{D_e = 41.5\ ft}$

**Summary:**

The minimum sheetpile embedment was found through a simplistic analysis of force and moment equilibrium of a free-earth supported sheetpile wall. The embedment depth for factors of safety of 1.3 and 1.5 result in 14 feet and 18.5 feet of embedment into the aquifer, respectively, and hence fully penetrates the aquitard. Penetration of the aquitard is undesired as issues such as bottom blowout and piping become more probable.

## RECORD OF REVISIONS

| NO. | REASON FOR REVISION | BY | CHECKED | APPROVED/ ACCEPTED | DATE |
|---|---|---|---|---|---|
| 1 | Zac Requested Calculations Check | JDW | 06/07/12 | | |
| | | | | | |
| | | | | | |
| | | | | | |
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# APPENDIX B
# FIRM PROFILES AND KEY STAFF RESUMES

## OVERVIEW OF ANCHOR QEA

Anchor QEA is an environmental and engineering consulting company that specializes in projects with aquatic, shoreline, and water resource components. We are nationally recognized for coastal development, engineering, landscape architecture, dredging management, resource and regulatory agency permitting, water quality, habitat restoration, and construction management. Anchor QEA has offices on the across the country, including locations in Southern California and the San Francisco Bay Area. Our staff includes environmental planners, scientists, landscape architects, and construction managers who enjoy every opportunity to apply their technical skills and creativity on a wide range of projects.

Anchor QEA approaches projects in a collaborative, interdisciplinary manner. Our staff have unique experience with the following assessment, engineering, design, habitat restoration, and construction tasks:

- National Environmental Policy Act (NEPA)/California Environmental Quality Act (CEQA) documentation
- Federal, state, and local permitting
- Cultural resources studies
- Feasibility studies
- Landscape architecture
- Construction/bid documents
- Geotechnical engineering
- Coastal engineering
- Constructability review
- Dredging and disposal planning
- Equipment selection and evaluation
- Bid evaluation/contractor selection
- Construction management
- Compliance monitoring

Anchor QEA provides these services during all phases of project development and implementation, from initial planning through construction support, and has worked for private industries, public agencies and utilities, port authorities, architectural and engineering firms, and law firms. An important benefit of our technical diversity is the ability to address complex issues for projects involving multiple disciplines, as we have specialized experience in taking projects from investigation and design through planning and permitting, construction management, and long-term monitoring. We lead and support many high-profile local, regional, and national waterfront cleanup projects, including such recent regional examples as the Rhine Channel sediment cleanup in Newport Beach; I.R. Site 7, West Basin, and Pier G and Middle Harbor Slip Fills at the Port of Long Beach; and the Port of Hueneme Confined Aquatic Disposal (CAD) Facility for the Oxnard Harbor District. Anchor QEA also has permitted, designed, and managed numerous maintenance dredging episodes for port facilities, municipalities, marinas, and other private clients.

We have earned a reputation with clients for our proactive approach on projects, our technical expertise, our quality of work, and our commitment to meeting project goals on schedule. Additional information about Anchor QEA can be found at www.anchorqea.com.

# DAVID W. TEMPLETON

**Principal Scientist**

## PROFESSIONAL HISTORY

Anchor QEA, Principal Scientist, 1998 to Present
Foster Wheeler, 1998 to 1999
Hart Crowser 1991 to 1998

## EDUCATION

University of Washington, Management Program, School of Business Administration, 2001
Western Washington University, M.S., Environmental Chemistry, 1991
Western Washington University, B.S., Marine Biology/Chemistry, 1982

## EXPERIENCE SUMMARY

David Templeton has more than 21 years of experience bringing complex sediment remedial investigation/feasibility study (RI/FS) projects with multiple objectives to successful completion through the careful coordination and management of a multidisciplinary team of environmental, engineering, and sediment management professionals. Having taken numerous projects through the investigation phase to construction, David has a think forward perspective that allows him to identify key issues early in the process. He has worked on sediment sites his entire career and is responsible for developing technically defensible effective strategies that blend habitat and permitting elements with practical site remediation solutions. In addition, he has extensive experience applying federal and state sediment criteria to the characterization and remediation of contaminated sediments. He is also experienced with ecological and human-health risk management issues as they apply to contaminated sediment sites, including fingerprinting of polycyclic aromatic hydrocarbons (PAHs). He has researched the fate and migration of PAH contaminants and the behavior of organotins (e.g., tributyltin [TBT]) in the aquatic environment. As an instructor for the U.S. Army Corps of Engineers' Dredging Fundamentals course, Mr. Templeton is well versed in dredging issues. Mr. Templeton also conducts peer reviews for research on sediment chemistry proposed for publication in *Environmental Toxicology and Chemistry*. Mr. Templeton also provides expert testimony for litigation support and insurance matters.

## REPRESENTATIVE PROJECT EXPERIENCE

### San Diego Shipyards Sediment Cleanup, San Diego, California

Mr. Templeton was initially retained by Southwest Marine (since purchased by BAE) and National Steel and Shipbuilding Company (NASSCO) to assist with the alternatives evaluation (supporting Exponent) and sediment remediation design for these two active shipyards. In response to the Regional Water Quality Control Board (RWQCB), activities included an evaluation of alternatives that considered various sediment cleanup levels, source control, technical feasibility, shipyard operations, and economic considerations to arrive at an achievable and implementable remediation scenario. The remediation scenario considered dredging, capping, and habitat enhancements. The FS was completed in late 2003. Anchor QEA has been assisting NASSCO and BAE with the negotiation of a Cleanup and Abatement Order (CAO), the development of a cost model for implementation of the CAO, and other issues necessary to prepare for design and implementation of the sediment cleanup process.

### Commencement Bay Nearshore/Tideflats Superfund Site - Middle Waterway Problem Area, Tacoma, Washington

Mr. Templeton was retained by a group of primary responsible parties (PRPs) to perform Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) pre-remedial and remedial design (PRD/RD) and construction services for this sediment problem area. Mr. Templeton serves as client manager and project manager. He serves as the project coordinator of record and has had involvement beginning with strategy development in response to the Record of Decision (ROD), negotiation of an Administrative Order on Consent (AOC) and Statement of Work (SOW), and preparation of preliminary cost estimates. The AOC became effective April 14, 1997, and key staff summarized existing data and prepared PRD/RD Work Plans. Anchor performed sediment and water quality sampling and analyses. To support design of the dredging plans and permitting requirements, a biological assessment (BA) was performed. This effort included an evaluation of how the dredging action will affect salmonid habitat. Specifically, we evaluated existing habitat, water quality impacts during dredging, various construction techniques, and habitat function (salmonids) to develop a dredge design that meets cleanup objectives, navigation requirements, expected 401 Water Quality Certification elements, the 404 process, and Endangered Species Act (ESA) consultation requirements. Based on these considerations and discussions with the permitting agencies, final design was completed in spring of 2003. Mr. Templeton also provided expert testimony for litigation support (third party issues) and insurance matters.

In addition, Anchor performed the construction management (CM) of the project. The project consisted of dredging and disposing of over 100,000 cy of contaminated sediment, placing 40,000 tons of cap/backfill material, installing a new bulkhead, demolishing 70,000 square feet of overwater structures, and enhancing shoreline fish habitat. The results of the project have been considered successful by the PRPs and regulatory agencies. Anchor won an award of merit from the Construction Management Association of America, Pacific Northwest Chapter for our CM work on the project.

### Eddon Boatyard, Gig Harbor, Washington

In 2004, the residents of the City of Gig Harbor approved the $3.5 million Proposition No. 1 Land Acquisition and Development General Obligation Bond (Proposition No. 1) to preserve a portion of the historic waterfront known as the Eddon Boathouse property. After completing a review of environmental conditions, the City purchased the property in March 2005. Mr. Templeton was retained to direct a strategy for this property that will achieve closure under the Washington State Model Toxics Control Act (MTCA) and the SMS and develop the property into a City park.

**8801 East Marginal Way Property, Duwamish River, Seattle, Washington**

Mr. Templeton was retained to provide MTCA/SMS expertise to support a property transaction. Currently, Mr. Templeton is supporting the negotiation of a Washington State Department of Ecology (Ecology) Agreed Order (AO) to address sediment issues adjacent to the property. He also provided expert testimony for litigation support (third party issues) and insurance matters.

**Jorgensen Forge Corporation, Duwamish River, Seattle, Washington**

Mr. Templeton was retained to develop and implement an overall site strategy for environmental issues. Mr. Templeton has negotiated an Ecology AO to perform an RI/FS that addresses source control and upland issues on the property, developed source control actions and addressed NDPES requirements. This work is integrated with work performed under an EPA AOC for development of an EECA to address adjacent sediments. Currently, a sediment removal order is being negotiated for implementation of a sediment and bank cleanup identified in the EECA. He also provided expert testimony for litigation support (third party issues) and insurance matters and supports an NRD restoration based settlement.

**Duwamish Shipyard, Inc., Duwamish River, Seattle, Washington**

As project manager, Mr. Templeton designed, developed, and negotiated a chemical and biological sediment monitoring program to meet NPDES requirements and to assess the shipyard's compliance with SMS. In addition, he managed the remediation of upland soil and groundwater to meet MTCA criteria. Currently, Mr. Templeton is evaluating existing information to support the development of an RI/FS for upland and sediments under an Ecology AO that will lead to an early action sediment remediation under the SMS (with EPA input).

**Slip 3 Fox Avenue Facility, Duwamish River, Seattle, Washington**

Mr. Templeton serves as project manager for all aspects of environmental operations on behalf of this property. Working all aspects of the property over the last 10 years, he has investigated sediment quality under the SMS, designed dredging and construction activities to meet Puget Sound Dredge Disposal Analysis (PSDDA) requirements, performed preliminary environmental assessments under MTCA to support property transfer. Currently, Mr. Templeton is evaluating existing information to support the development of an RI/FS that will lead to an early action sediment remediation. He also provided expert testimony for litigation support (third party issues) and insurance matters.

**Foss Maritime, Tacoma, Washington**

Mr. Templeton assists Foss Maritime with a number of aquatic parcels of which a majority are managed by DNR and involve issues associated with log booming and log rafting activities. DNR aquatic land lease terms are unclear as to how DNR should assess and address wood debris issues. By staying abreast of DNR interim guidance and working closely with Ecology site managers as they dedicated more resources to this issue, Mr. Templeton is central to working out site strategies that focus on practical lease termination strategies that meet the requirements of SMS. Sites include the West Hylebos Log Storage Area (Tacoma), Port Angeles, and Longview.

# MICHAEL WHELAN, P.E.

**Senior Managing Engineer**

## EDUCATION

B.S. Geological Engineering, Colorado School of Mines, 1990
M.S. Environmental Engineering, Georgia Institute of Technology, 1992
M.S. Geotechnical Engineering, Massachusetts Institute of Technology, 1995

## PROFESSIONAL REGISTRATIONS AND MEMBERSHIPS

Professional Engineer, licensed in Washington and California
Member, Western Dredging Association (WEDA)
Member, American Society of Civil Engineers (ASCE)

## PROFESSIONAL EXPERIENCE

Michael Whelan's 15 years of experience as a civil, environmental, and geotechnical engineer includes management, design, and oversight of numerous sediment remediation, restoration, monitoring, and development projects for both offshore and upland sites around the United States. His background in environmental engineering, coupled with his extensive experience with civil and sediment design, allows him to develop cost-effective and readily implemented design and construction approaches for remediation projects involving waterfront cleanup and construction, stabilization of landslide areas and offshore slopes, and design of nearshore and offshore waste containment facilities and upland landfill caps. Mr. Whelan specializes in managing sediment characterization studies, negotiation of cleanup requirements with regulatory agencies, comparative evaluations of design alternatives, creation of plans, specifications, and cost estimates, assistance with bidding and contractor selection, and construction oversight and management. His technical expertise in engineering and design includes management of sediment remedial actions (involving dredging, excavations, capping, and confined disposal facilities), field exploration and laboratory testing programs, and geotechnical analyses of slope stability and seismic effects on marine structures and slopes.

## REPRESENTATIVE PROJECT EXPERIENCE

### Port Hueneme Maintenance Dredging and CAD Site Construction, Port Hueneme, California

Mr. Whelan is the lead civil and environmental engineer for this project involving development of a multi-user confined aquatic disposal (CAD) site for contaminated sediments within Port Hueneme. The project consists of three distinct phases: 1) excavating a large pit in the middle of the harbor and placing the clean sand onto an adjacent beach; 2) dredging contaminated sediment from the Federal Channel, Oxnard Harbor District docks, and Navy docks and placing the material into the CAD cell; and 3) constructing a clean cap of sand on top of the contaminated layer to seal the cell and prevent chemical migration. Specific design elements of this project include dredging design, resistance to erosion, modeling of chemical breakthrough and water quality impacts, and consolidation of materials placed within the CAD.

### Newport Harbor/Rhine Channel Sediment Investigation and Alternatives Evaluation, Newport Beach, California

Mr. Whelan is Anchor QEA's lead engineer for the engineering evaluation and development of conceptual cost estimates for various remedial alternatives of contaminated sediment in Newport Harbor and the Rhine Channel, a waterway area that is heavily used by public, business, and industrial interests. Specific responsibilities included determining overall volume of impacted sediments, developing cost-effective and technically feasible methods for removing or managing the sediments, and reviewing structural conditions of existing seawalls and facilities in the channel. To date, Mr. Whelan's engineering findings and conclusions have been documented in a Draft Feasibility Study and Alternatives Evaluation.

### BAE Systems and NASSCO Shipyards, San Diego, California

Mr. Whelan is the lead engineer responsible for developing cost estimates and input regarding technical and economic feasibility of various cleanup alternatives. In this capacity, he has led Anchor QEA's technical team in determining overall costs and implementability of alternative remedial solutions, including dredging, capping, and natural recovery. His responsibilities also include identifying potential impacts of remedial actions on existing marine structures and facilities and providing engineering support to ongoing negotiations with regulatory agencies. Mr. Whelan also worked closely with BAE Systems' San Diego Ship Repair Facility to plan and oversee construction of a bulkhead extension and yard improvement project.

### Thea Foss Waterway Sediment Remediation and Disposal Facility, Tacoma, Washington

Mr. Whelan performed and supervised geotechnical and civil engineering analyses of waterway dredging and capping, including design of two waterway disposal sites: excavation and infilling of a CAD site, and infilling of a nearby waterway with dredged sediment to form a CDF. Analyses included the effects of dredging on adjacent slopes and structures and consolidation of placed sediment within the CDF. He also designed required habitat improvements, including excavation of a hog-fuel storage area to re-establish a former wetland.

### Eagle Harbor Remediation and Nearshore Fill Construction, Bainbridge Island, Washington

Mr. Whelan was responsible for engineering design, construction observation, and post-construction monitoring for this sediment remediation project, which involved dredging, on-site containment in a constructed nearshore containment facility, and soil stabilization for pavement section installation.

# JOHN R. VERDUIN III, P.E.

**Principal Engineer**

## EDUCATION

Purdue University, M.S., Engineering, 1988

University of Missouri-Rolla, B.S., Geological Engineering, 1986

## EXPERIENCE SUMMARY

John Verduin has more than 21 years of experience applying innovative engineering approaches to port, harbor, and waterway projects throughout the United States. As a senior engineer at Anchor Environmental, he is responsible for completing geotechnical engineering studies, analyzing contaminant transport mechanisms, managing structural and hydrographic waterway surveys, developing and evaluating remedial engineering approaches and cost estimates, and designing and implementing remedial actions, including preparation of plans, specifications, support documentation, and construction oversight. Mr. Verduin is uniquely qualified to evaluate the full range of potential contaminated sediment remedial alternatives, being one of the few engineers in the country to actually design and see implemented (during construction) many of the different available remedial alternatives. He has designed remedial alternatives involving natural recovery, enhanced natural recovery, *in situ* capping, mechanical and hydraulic dredging, confined disposal, and treatment. Mr. Verduin's strong background in geotechnical/civil engineering also allows him to integrate aspects of the potential remedial solution into future development needs.

## REPRESENTATIVE PROJECT EXPERIENCE

### Onondaga Lake Feasibility Study and Remedial Design, Syracuse, New York

Mr. Verduin provided senior engineering and design review of an effluent canal remediation project for an industrial facility in Lake Charles, Louisiana. The project entails sediment capping, dredging of a new channel, creation of new wetlands, levee construction, pedestrian bridge installation, and vehicular bridge rehabilitation. Anchor developed a work plan and implemented geotechnical soil sampling and vane shear strength testing at a variety of locations within a shallow water marsh and in the flowing canal system. In addition, Anchor evaluated potential settlement of new berms, and analyzed the stability of embankment fill that will be placed over soft marsh sediments. Anchor performed slope stability and settlement geotechnical evaluations and prepared the design package for a new canal and levee system being dredged through a subsided marsh area. Dredge material is being beneficially reused to create new marsh habitat within perimeter levees constructed for the project. The year-long project is currently under construction.

### Terminal 4, Port of Portland Removal Action, Willamette River, Portland, Oregon

Anchor QEA is leading the design for a removal action at the Port of Portland's Terminal 4 facility on the Willamette River. The first phase of the project involved dredging of contaminated sediments with upland disposal, in situ capping, and stabilization of a shoreline bank. Mr. Verduin is the project engineer leading the design team. Anchor QEA developed construction documents, assisted the port with contractor evaluation and procurement, and provided the port with construction support services. Anchor QEA is currently working on the

Phase II design, which entails constructing an on-site nearshore confined disposal facility to contain additional dredged sediments from Terminal 4, as well as sediments from other sites in the harbor, and in situ capping.

**Los Angeles County Dredged Material Management Plan Pilot Studies, Los Angeles, California**

Anchor QEA assisted the Los Angeles District U.S. Army Corps of Engineers (USACE) in implementing four remediation alternative pilot/bench scale studies to evaluate the technologies for use in a regional Dredged Material Management Plan for the Los Angeles and Long Beach area. The four remediation/disposal alternatives included: aquatic capping, cement-based stabilization, sediment washing for chloride removal, and sediment blending. Mr. Verduin was the project engineer for the aquatic-capping pilot study. Technical tasks being performed by Anchor QEA include: preparation of sampling and analysis plans, short-term and long-term monitoring plans, modeling studies for contaminant mobility and sediment transport, oversight of sediment characterization efforts (i.e., chemical, contaminant mobility, physical, and geotechnical testing), workplans for the treatability bench scale studies, engineering design, bid plans and specifications, construction management, monitoring oversight, and preparation of evaluation reports for each remedial alternative. Anchor QEA also assisted the Los Angeles District USACE in permitting activities and regulatory coordination including: preparation of the National Environmental Policy Act Environmental Assessment, Coastal Commission Consistency Determination, and COE 404(b)1 analysis.

**East Waterway Deepening Project, Seattle, Washington**

Mr. Verduin was the project engineer during dredging of the East Waterway. Anchor QEA, working for the Port of Seattle and the USACE, completed the design and assisted the USACE in the preparation of the construction documents for this complex marine project. The project involved the dredging and open water disposal of 140,000 cy of clean navigational material as well as the dredging and upland disposal of 80,000 cy of contaminated sediment. The contaminated sediment was mechanically dredged using environmental buckets and standard clamshell buckets. The material was then offloaded where it was treated with a lime additive. Surface water was captured and treated before discharging. A pilot study was completed prior to construction to evaluate the effectiveness of using environmental buckets. The conclusion of the study that environmental buckets would have limited success in the East Waterway was confirmed during construction.

# ATTACHMENT 2-B

# Critique of the National Contingency Plan Consistency of US EPA's September 2010 Record of Decision for the Ashland/Northern States Power Lakefront Site

Prepared by

Kurt Herman, M. Eng., P.G.

Prepared for
Northern States Power Company,
a Wisconsin Corporation (NSPW)

October 11, 2012

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# Abbreviations

| | |
|---|---|
| ARAR | Applicable or Relevant and Appropriate Requirement |
| BERA | Baseline Ecological Risk Assessment |
| BMP | Best Management Practice |
| CD | Consent Decree |
| CDF | Confined Disposal Facility |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| DNAPL | Dense Non-aqueous Phase Liquid |
| FS | Feasibility Study |
| HHRA | Human Health Risk Assessment |
| IER | Island End River |
| MGP | Manufactured Gas Plant |
| NAPL | Non-aqueous Phase Liquid |
| NCP | National Contingency Plan |
| NPL | National Priorities List |
| NSPW | Northern States Power Company, a Wisconsin Corporation |
| PAH | Polycyclic Aromatic Hydrocarbon |
| PCB | Polychlorinated Biphenyl |
| PRAP | Proposed Remedial Action Plan |
| PRG | Preliminary Remediation Goal |
| PRP | Potentially Responsible Party |
| RI | Remedial Investigation |
| ROD | Record of Decision |
| SLRIDT | St. Louis River/Interlake/Duluth Tar |
| SWAC | Surface-weighted Average Concentration |
| US ACOE | United States Army Corps of Engineers |
| US EPA | United States Environmental Protection Agency |
| WDNR | Wisconsin Department of Natural Resources |

# 1 Introduction

The National Contingency Plan (NCP) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, also known as "Superfund") require that the United States Environmental Protection Agency (US EPA) select and implement "CERCLA-quality" remedies that cost-effectively protect human health and the environment and are technically implementable. US EPA has not met this burden at the Ashland/Northern States Power Lakefront Site ("Ashland Site") by selecting the unprecedented, potentially dangerous, and costly SED-6 "hybrid"[1] dredging alternative for sediment remediation. They selection in the September 2010 Record of Decision (ROD) (US EPA Region V, 2010) was arbitrary and capricious because the remedy selected could result in significant risk to human health and the environment. Other viable sediment remediation alternatives [*e.g.*, the SED-4 "wet" dredging alternative and SED-2 Confined Disposal Facility (CDF) alternative] which do not pose these same risks were rejected based on flawed remedy selection analysis.

This report expresses the conclusions of Gradient, on behalf of Northern States Power Company, a Wisconsin corporation (NSPW), regarding the flawed remedy selection reflected in the ROD for the Ashland Site. This report incorporates by reference NSPW's prior comments on the proposed remedy[2] and the proposed sediment Performance Standards,[3] to which Gradient contributed its technical analyses.

This report has also been prepared in response to new, material information provided by US EPA and its contractors after the public comment period for US EPA's Proposed Remedial Action Plan (PRAP) ended (US EPA, 2009). This new information includes, for example, the final SED-4 wet dredge performance standards included in the 2010 ROD; Weston's 2009 Technical Memorandum titled "Conceptual Geotechnical Assessment for Sediment Removal"; new information and analyses introduced by US EPA *via* the Responsiveness Summary attached to the 2010 ROD (such as the "dry dredge" precedent sites cited by US EPA), *etc.* The public, including NSPW, has not been provided the opportunity to comment on this new information that serves, in part, as the basis for US EPA's sediment remedy decision-making. As such, the ROD does not appear to satisfy NCP and CERCLA requirements for community involvement in the remedy selection process.[4]

This report is organized as follows. Section 2 provides an overview of Gradient's pertinent qualifications. Section 3 provides relevant background on the Ashland Site (Section 3.1), as well as NCP and CERCLA requirements (Section 3.2). Sections 4-6 provide Gradient's analysis, the main conclusions of which are summarized below (and reiterated in Section 7).

[1] The term "hybrid" refers to the combination of conventional wet dredging techniques with "dry" dredging techniques that would require dewatering a portion of the Great Lakes.
[2] NSPW, 2009a (PRAP comments cover letter), and NSPW, 2009b (referred to herein as "PRAP Comments").
[3] NSPW, 2008; Winslow *et al*., 2009; Winslow, 2009; Crass, 2009; Leifer, 2009.
[4] For example, Section 300.155 of the NCP states that the oversight agency "should ensure that all appropriate public and private interests are kept informed and that their concerns are considered throughout a response."

**Summary of Conclusions**

1. US EPA's Comparative Analysis of the sediment remedy alternatives for the Ashland Site – which led to selection of the hybrid wet/dry dredge remedy alternative (SED-6) over other viable remedy alternatives – is materially flawed and inconsistent with the NCP. This is because:

   - SED-6 is not protective. There are key safety issues associated with its implementation that could lead to catastrophic remedy failure resulting in significant harm to human health and the environment, including to remediation workers and potentially the community.

     - Such catastrophic failure could result in loss of life, mobilization of affected sediments into the relatively pristine portions of Lake Superior, and mobilization of the deep Copper Falls groundwater plume, causing greater environmental impacts.

   - The implementation of the "dry dredge" component of SED-6 in the open waters of Lake Superior, the largest of the Great Lakes and the largest fresh water lake in the world, is unprecedented.

   - SED-6 is not cost-effective because there were more protective options available to US EPA at significantly lower cost (up to $30-40M less, based on the 2008 Feasibility Study [FS]).

2. Other viable remedy alternatives described in the ROD, either the SED-4 wet dredge or the SED-2 CDF remedy alternative, should have been selected by US EPA because they do not pose the same issues described above, and they are objectively superior based on the NCP and CERCLA remedy selection criteria. Further, these alternatives could be "fine-tuned" beyond how they are conceived in the ROD to improve their effectiveness.

3. The ROD provision for a wet dredge pilot test is illusory because the wet dredge Performance Standards set in the ROD, if strictly interpreted, are unnecessarily conservative and not achievable. However, a more reasonable interpretation of these same wet dredge Performance Standards may still achieve a protective wet dredge remedy.

# 2 Qualifications

Gradient is a specialty environmental consulting firm with more than 25 years of experience developing cost-effective, protective solutions to complex environmental issues across the country and abroad. Gradient's professionals are recognized experts in their fields. We have worked at some of the nation's most publicized sediment sites, from the Housatonic to the Passaic and Hudson Rivers, including dozens of National Priorities List (NPL) sites. Gradient has experience with more than 200 manufactured gas plant (MGP) and wood-treating sites throughout the country.

Gradient has been addressing NPL sites since it was founded. Soon after CERCLA was enacted in 1980, Gradient began working on some of the then most high-profile NPL sites, such as Love Canal, Hyde Park, and 102nd Street in the Niagara Falls area. Gradient worked on these sites on behalf of US EPA, providing independent oversight of the Remedial Investigation/Feasibility Study (RI/FS) activities performed by the potentially responsible parties (PRPs) and site-specific risk assessment services. Gradient has also worked on behalf of US EPA at other high-profile NPL sites, including the GM Massena (St. Lawrence River) and the Hudson River polychlorinated biphenyl (PCB) sites, as well as for a wide range of private PRPs on other NPL Sites nationwide, including many sites within US EPA Region V.

I am personally qualified to discuss these topics because of my educational background, experience with non-aqueous phase liquid (NAPL) and polycyclic aromatic hydrocarbons (PAHs), and sediment-related expertise. I am a Principal Scientist at Gradient and have expertise in evaluating the sources, fate, and transport of contaminants in the environment. I have earned a Master of Engineering degree in Environmental Engineering from MIT and a BA in Economics and Geology from Miami University (Ohio). I have more than 13 years of professional experience in environmental consulting. I have provided consulting and expert support at more than 80 former MGP and wood-treating sites, including the evaluation of PAHs and NAPL in sediments. I have led a wide range of site characterization and remediation efforts at the state, federal, and international level, and my consulting practice includes contaminant fate and transport analysis; the development of protective and cost-effective remedial approaches to hazardous waste sites; environmental liability cost estimation; and environmental response cost recovery/allocation, including NCP-consistency analysis. Attachment 1 provides further information about my educational and professional experience.

# 3 Background

## 3.1 Ashland Site Overview

NSPW has been working with US EPA, the Wisconsin Department of Natural Resources (WDNR), and the City of Ashland ("City") since 1995 to address Ashland Site contamination. The actions NSPW has undertaken to date include the following:

- Conducted comprehensive environmental studies, culminating in the RI/FS and accompanying human health and ecological risk assessments for the entire Ashland Site;
- Performed several Interim Remedial Measures, including the removal of a tar well from the former MGP site, installing and operating a NAPL and groundwater extraction system for deep (Copper Falls Aquifer) and shallow groundwater in the Upper Bluff, and removing/capping impacted soil from the "Seep Area" of Kreher Park;
- Reimbursed US EPA and WDNR for certain oversight and response costs;
- Entered into a Framework Agreement in 2008 with the City and WDNR to advance mutual goals at the Site in a cooperative manner;
- Participated in negotiations with US EPA and WDNR regarding the sediment remedy, including the role of the wet dredge pilot study and reasonable Performance Standards. These negotiations were put on hold while the Uplands Consent Decree (CD) was negotiated (see bullet below); and
- Entered into a CD with US EPA and WDNR to perform Upland Site remediation of impacted soil and groundwater as specified in the CD Statement of Work and in accordance with the 2010 ROD (currently pending court approval).

However, NSPW continues to strongly disagree with US EPA regarding its selection in the ROD of the SED-6 hybrid dredging alternative for sediment remediation. Following execution of the Uplands CD, NSPW is preparing to re-engage in sediment negotiations with US EPA; as part of this process, NSPW requested that Gradient analyze the technical issues with the hybrid remedy raised by Weston and review the ROD Comparative Analysis in light of the Weston Report. As demonstrated in the 2009 PRAP comments, SED-6 is a costly and potentially dangerous remedy that is unprecedented for such an open water Great Lakes setting that should not have been selected. At that time, NSPW presented the SED-4 wet dredge alternative as a viable, superior alternative, contingent upon US EPA setting realistic wet dredge Performance Standards.[5] While the ROD did provide for a pilot of the SED-4 wet dredge alternative, the pilot Performance Standards are not achievable if strictly interpreted as written (US EPA Region V, 2010, pp. 92-94) and, are therefore arbitrary and capricious. These unnecessarily stringent wet dredge Performance Standards render the SED-4 alternative technically impracticable under these conditions.

Thus, because: (1) SED-6 is not protective of human health or the environment, and (2) the SED-4 alternative has been rendered technically impracticable based on the Performance Standards US EPA set in the ROD, NSPW continues to assert that a different sediment remedy alternative should be performed

[5] Performance Standards are cleanup goals used to gauge sediment remedy effectiveness.

at the Site, and is willing to discuss any other reasonable sediment remedy with the agencies, including those presented in the FS, such as the SED-2 CDF and SED-4 wet dredge alternative with technically achievable Performance Standards. NSPW is also willing to consider improvements to make other viable options available in the FS, PRAP, and ROD even better. For example, to address the ROD-stated concern for the SED-2 CDF alternative that it "would not result in a reduction in the toxicity, mobility, or volume," (p. 68) the SED-2 CDF alternative could be readily modified to incorporate horizontal and vertical recovery NAPL extraction wells, or the contained sediment mass could be permanently stabilized by amending it with *in-situ* additives.

## 3.2 The National Contingency Plan and CERCLA

The NCP, first issued in 1968, evolved from the Clean Water Act's governance of oil spill cleanup and became the fundamental guiding principle of Superfund activities. Its adaptation to CERCLA was first formalized in July 1982 and, later amended several times. The NCP is designed to ensure that cost-effective, environmentally protective cleanups are performed in a relatively standardized way throughout the nation, and that there is a consistent, objective basis for remedy decision-making. The key objectives of the NCP are to:

- Institute a plan for national preparedness where responsibilities and authorities of Federal, State, and private parties are established for addressing hazardous waste issues;
- Investigate reported releases of hazardous materials;
- Study sites appropriately (*i.e.*, appropriate scope of study, data quality, and worker protection);
- Quickly respond to timely and technically obvious cleanup needs (Removal Actions);
- Identify and prioritize longer term and more complex contaminated sites *via* the NPL;
- Study the longer-term and more complex contaminated sites and select remedies *via* the RI/FS process;
- Design and implement selected remedies in a technically sound and cost-effective manner;
- Document the information and decision-making process; and
- Provide the public necessary information, as appropriate.

In its NCP promulgation notice of 1990, US EPA defined its perspective on the "CERCLA-quality" cleanup of hazardous waste (US EPA, 1990). According to US EPA, such activity must:

- Be protective of human health and the environment;
- Utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable;
- Be cost-effective;
- Attain Applicable or Relevant and Appropriate Requirements (ARARs); and
- Provide for meaningful public participation.

Regarding the last item in the list above, Section 300.155 of the NCP states that the oversight agency "should ensure that all appropriate public and private interests are kept informed and that their concerns are considered throughout a response." The public (including NSPW) has not been provided the opportunity to comment on this new information (including the Weston report) which serves, in part, as the basis for US EPA's sediment remedy decision-making. As such, the ROD does not appear to satisfy NCP and CERCLA requirements for community involvement in the remedy selection process.

If the lead agency decides *remedial* action is needed, as is the case with impacted sediments at the Ashland Site, the following steps are required, according to the NCP (Section 300.430):

- Completion of an RI/FS, which is a thorough site investigation involving sampling, data evaluation, and remedy alternative screening. In the FS, remedy alternatives are to be evaluated and compared on the basis of ***nine criteria*** (300.430(e)(9)(iii)).
- Selection of a remedy upon the same ***nine criteria*** (300.430(f)); the overarching "purpose of the remedy selection process is to implement remedies that eliminate, reduce, or control risks to human health of the environment." (300.430(a)). This "Comparative Analysis" process provides the framework for evaluating and comparing remedial alternatives that is intended to ensure rational selection of a remedy (NCP 300.430(f)).

The nine criteria warrant further discussion because they not only provide the basis for lead agency remedy selection under the NCP[6] and CERCLA guidance (US EPA, 1990, 1997), but they also provide a basis under CERCLA for a court to determine whether an agency decision is arbitrary and capricious.[7]

The nine criteria are:

- All selected remedies must satisfy the ***Threshold Criteria***:
  1. Overall protection of human health and the environment, and
  2. Compliance with ARARs.
- Among alternatives that satisfy the Threshold Criteria, the preferred remedy is selected based on an evaluation of the ***Balancing Criteria***:
  3. Long-term effectiveness and permanence;
  4. Reduction in toxicity, mobility, and volume of waste;
  5. Short-term effectiveness;
  6. Implementability;
  7. Cost; and
- ***Modifying Criteria***:
  8. State Support/Agency acceptance; and
  9. Community acceptance.

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[6] Consistent with these nine criteria, CERCLA § 121 mandates that remedial actions selected by US EPA must adhere to the following criteria: (1) Protect human health and the environment; (2) Comply with ARARs unless a waiver is justified; (3) Be cost-effective; (4) Utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and (5) Satisfy the preference for treatment as a principal element, or provide an explanation in the ROD of why the preference was not met.

[7] See, *e.g.*, CERCLA § 9613(j)(2): "In considering objections raised in any judicial action under this chapter, the court shall uphold the President's decision in selecting the response action <u>*unless*</u> the objecting party can demonstrate, on the administrative record, <u>*that the decision was arbitrary and capricious*</u> or otherwise not in accordance with law" (emphasis added).

As described herein, US EPA has selected a sediment remedy that fails to meet the threshold criteria of protectiveness, which all remedies must achieve; its remedy selection process was arbitrary and capricious to arrive at this outcome when protective alternatives were and are available. In addition, the selected remedy is also deficient for the Balancing Criteria of short-term effectiveness, implementability, and cost, which casts further doubt on its appropriateness. Further, US EPA's selection of the SED-6 alternative is contrary to the City's stated preference for a safe, protective remedy (Monroe and Peterson, 2009[8]); thus, the ROD-selected remedy is also deficient with regard to the Modifying Criteria of Community acceptance.

[8] "It is important that the cleanup be protective of human health and the environment…It is important that the clean-up be protective of the neighborhood."

# 4 The Comparative Analysis of Sediment Remedial Alternatives Presented in the ROD is Flawed, Leading to Selection of the Unprecedented, Potentially Dangerous, and Costly Hybrid Wet/Dry Dredge Remedy Alternative (SED-6)

As presented in the ROD (US EPA Region V, 2010, pp. 62-73), the Comparative Analysis of the sediment remedy alternatives for the Ashland Site – which led to selection of the hybrid wet/dry dredge remedy alternative (SED-6) over other viable remedy alternatives – is materially flawed and inconsistent with the NCP. An objective analysis of the NCP remedy selection criteria described in Section 3.2 demonstrates that other options, such as the SED-4 wet dredge or the SED-2 CDF remedies, are superior alternatives that should have been selected.

## 4.1 SED-6 is Not Protective

The key safety issues associated with the SED-6 hybrid dredging remedial alternative are attributable to the Ashland Site's setting (*i.e.*, on one of the world's largest fresh water lakes) and the scope of the sediment dredging (approximately 130,000 $yd^3$). In order to implement the dry dredging remedial alternative, a retaining structure would need to be constructed to dewater and expose the sediments to be dredged. This is an extremely unsafe, multi-year proposition given the potential loading on the retaining structure from ice and other Lake Superior-related forces. In addition, dewatering of Chequamegon Bay may breach the underlying aquitard, resulting in significant upward flow of underlying "artesian" groundwater (referred to as "basal heave") and causing potentially catastrophic failure of the retaining structure. Such catastrophic failure could result in loss of life, mobilization of affected sediments into the relatively pristine portions of Lake Superior, and mobilization of the deep Copper Falls groundwater plume, causing greater environmental impacts.

As described below, while the ROD correctly stated that there are "increased concerns with worker safety in a dry excavation [SED-6] scenario" (US EPA Region V, 2010, p. 70), these concerns are dismissed by stating that "there are effective and reliable mitigative measures that will be developed during the design phase" (US EPA Region V, 2010, p. 70). The ROD never identifies these mitigative measures nor evaluates their potential to reduce the risks inherent in SED-6 to a level at least comparable to other sediment remedy alternatives. US EPA's contractor, Weston Solutions, Inc. (Weston), elaborated on these concerns in a Technical Memorandum, stating that there are "significant worker/equipment safety concerns" and several "'fatal flaw' failure mechanisms" unique to the dry dredge remedy alternative (Weston, 2009).

Weston simply referenced design-stage planning and engineering controls to address significant risks and flaws associated with SED-6. This "solution" artificially inflated SED-6's scoring/evaluation, and the same approach was not applied to other alternatives, such as SED-4, when considering comparative scoring. This approach is neither objective nor faithful to the remedy selection process outlined in the

NCP, and it demonstrates the arbitrary and capricious nature of the remedy selection process that resulted in the ROD outcome.

### 4.1.1 Risks to Human Health and the Environment from SED-6 Remedy Failure

The bottom-line conclusion from the analyses performed by Weston in response to the "basal heave" analysis performed for NSPW is that implementing the SED-6 alternative has the potential for catastrophic "fatal flaw" failure with "significant worker/equipment safety concerns" (Weston, 2009). These safety risks likely exceed the relatively minor chemical exposure risks currently posed to human health and the environment at the Ashland Site. This "basal heave" analysis, presented in the PRAP comments (pp. 24-26), demonstrated that there are safety concerns uniquely associated with the "dry dredge" component of the SED-6 remedy alternative. Implementing SED-6 may lead to geotechnical failure posing significant risk to remediation workers and the environment. Basal heave failure would likely mobilize and release contaminated sediment to uncontaminated portions of Chequamegon Bay and breach the Miller Creek confining layer, thereby mobilizing the deep groundwater (Copper Falls Aquifer) contaminant plume. Thus, if geotechnical failure occurred, greater volumes of sediment and groundwater would be impacted. See Figure 1, below.

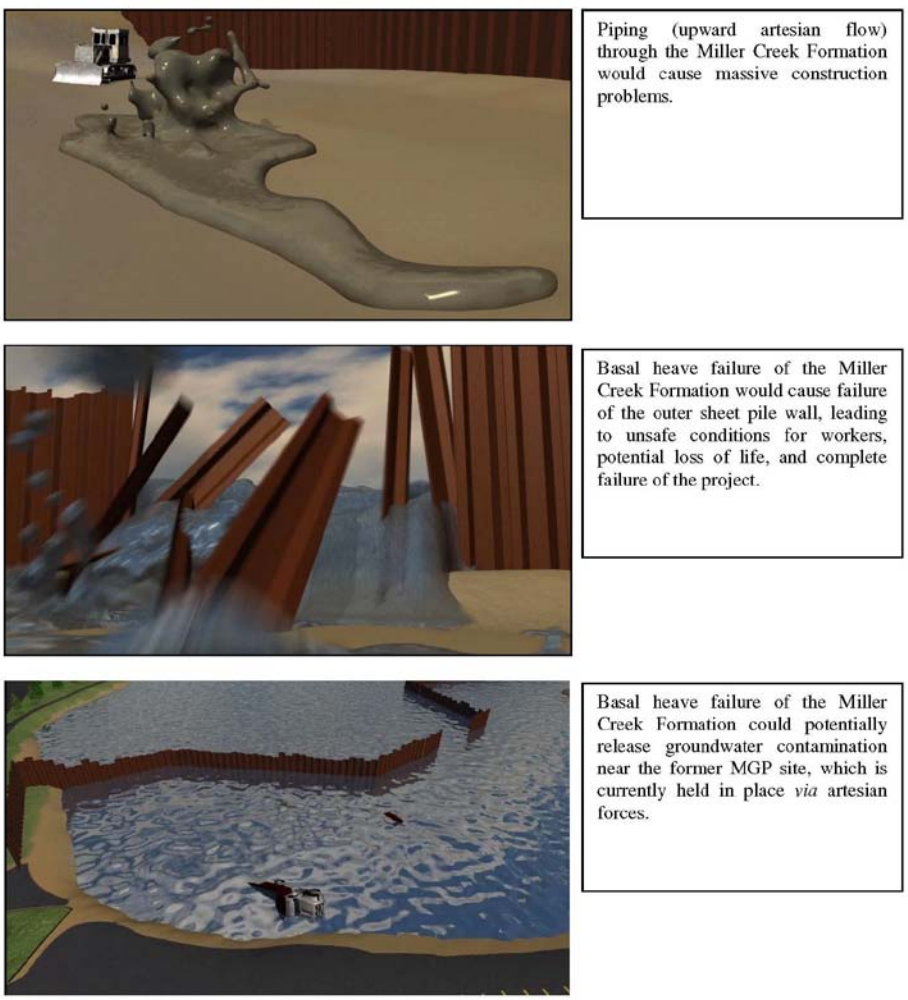


**Figure 1 Illustration of Potential Impacts from Basal Heave Failure at the Ashland Site**

Weston's 2009 Technical Memorandum was prepared for US EPA in response to this basal heave analysis. Weston downplayed what it referred to as the "basal heave phenomenon," suggesting that if basal heave failure occurred, the dry sediment bed would simply rise up slowly and smoothly against the sheet pile wall like an elevator in an office building. This simplistically ignores the synergistic effect that basal heave would have on the other geotechnical concerns raised by Weston (*i.e.*, basal heave would promote blowout or sheet pile wall failure; see below). In contrast, Foth included these other geotechnical concerns under the umbrella of what it referred to as "basal heave" – Figure 1 illustrates this.

The other geotechnical concerns raised by Weston clearly demonstrate the significant implementability and safety concerns associated with the SED-6 alternative that US EPA has selected in the ROD:

- The in-water sheet pile wall could fail;[9]
- The dry sediment excavation bottom could "blowout";[10] and
- The dry sediment excavation bottom could liquefy (piping or "quicksand" conditions).[11]

It is noteworthy that Weston (2009, p. 6) identified these concerns even without considering external forces "such as those due to wave and ice loading," which would make SED-6 even more prone to failure in an open water Great Lakes setting. Thus, Weston's analysis simply does not reflect actual conditions.

Weston dismissively states that these concerns, as well as those raised by NSPW, could be mitigated through the overly optimistic assumption that "conceptual planning, final design engineering and implementation of the construction work [would] all [be] properly executed" (Weston, 2009, p. 9). Weston offers little support, precedent, or detail concerning what measures could be undertaken to mitigate these risks except for a "segmenting" approach that would break the dry dredge footprint into relatively small cells (150 feet x 200 feet or less) separated by sheet pile walls. The extensive sheet piling required would:

1. dramatically slow down the remedy effort;
2. increase the remedy cost significantly; and
3. drag dense non-aqueous phase liquid (DNAPL) and PAHs in sediments down into deeper, uncontaminated strata and potentially introducing contamination into this portion of the Copper Falls Aquifer.

Such a "segmented" SED-6 approach bears little resemblance to what was selected in the ROD.

Thus, the ROD does not sufficiently evaluate these mitigating techniques to provide a basis for concluding that the risks posed by SED-6 can be controlled so as to render it at least comparable to SED-4 with regard to the Threshold Criteria of Protectiveness and to the Balancing Criteria of Short-Term Effectiveness, Implementability, and Reduction (in toxicity, mobility, and volume of waste).[12] Further, even if these concerns could be mitigated, which is unlikely, such that failure did not occur, the cost of the

[9] "Structural stability of the sheet pile retaining wall required to dry excavate bay bottom sediments" (Weston, 2009, p. 2).

[10] "Excavation bottom blowout due to shear failure of the cohesive aquitard soils induced by the dry excavation and the artesian head in the aquifer, which underlies the aquitard" (Weston, 2009, p. 2).

[11] "Piping (*i.e.*, liquefaction) of cohesionless bay bottom sand and silty sand sediments at the surface of the dry excavation due to upward hydraulic exit gradients" (Weston, 2009, p. 2).

[12] The ROD conveniently levels the playing field between SED-6 and SED-4 by assuming that remedial design and "reliable mitigative measures" can control for the heightened safety risks present with SED-6. Yet no similar consideration is extended to SED-4 for mitigative measures that control for sheens and turbidity. This small example of the imbalanced dealing in the ROD reveals its arbitrary and potentially outcome-driven nature.

mitigation measures would increase SED-6 remedy costs, rendering this remedy alternative even less cost-effective relative to other viable alternatives. The costs of these mitigative measures are not presented in either the Weston memorandum or the ROD.

### 4.1.2 Risks to Workers Due to Increased Duration of Construction

In addition to the risk from catastrophic geotechnical failure described above, Weston did not evaluate the incremental risk of worker injury/fatality posed by the SED-6 remedy alternative. As described in the 2009 PRAP comments, the hybrid dredge remediation alternative selected by US EPA poses a 23% greater risk of worker injury/fatality. Neither Weston nor US EPA conducted a rigorous comparative evaluation of short-term risks associated with the implementation of dry *versus* wet dredging, yet these increased risks of occupational death or injury associated with implementing SED-6 *versus* SED-4 (see PRAP comments at p. 27) were arbitrarily dismissed by stating "safety risks are either addressed by taking appropriate safety precautions or use of appropriate engineering controls" (US EPA Region V, 2010, p. A-16). Simply put, the longer the construction activity persists, the higher the risk of injury or death to workers and the community; US EPA has failed to factor this risk into its evaluation of the short-term effectiveness of the SED-6 *versus* the SED-4 remedy alternative.

### 4.1.3 Increased Volatile Air Emissions

Weston also did not consider increased volatile emissions associated with the SED-6 remedy alternative. The air emission analysis presented in the PRAP comments (pp. 28-29) indicates that implementation of the dry dredging sediment remediation alternative will result in a larger ambient air "plume" of hazardous pollutants (*e.g.*, benzene, naphthalene). If these increased emissions were factored into US EPA's analysis, SED-6 would fail to meet the same level of short-term effectiveness that other alternatives (*e.g.*, SED-4 and SED-2) provide. The increased potential risk to the community from air emissions resulting from the SED-6 dry dredge remedy was arbitrarily dismissed in the ROD, stating "this will be addressed during pre-design and design phase" and "use of appropriate engineering controls will be utilized" (US EPA Region V, 2010, p. A-16). Exposure risks during remediation should have been seriously considered in the Comparative Analysis.

## 4.2 SED-6 Fails the Implementability Criterion

Despite acknowledging that SED-6 "would be difficult to implement because of the need to install safe and watertight enclosures, [to] pump the surface water out…and [to implement] engineering controls for volatilization" (US EPA Region V, 2010, p. 71), this remediation technology was selected in the ROD. Further, the implementation of the "dry dredge" component of SED-6 in the open waters of the largest of the Great Lakes is unprecedented. In support of its decision, US EPA offered seven example sites (see US EPA Region V, 2010, p. A-18 through p. A-24) which it asserts serve as relevant precedent. No opportunity was provided for the public to comment on these seven sites as relevant precedent until they were included in the ROD.

These sites are simply not comparable to the Ashland Site in terms of scope, cost, setting, or environmental contaminants (see Table 1). These differences demonstrate that there is simply no precedent for this remediation approach at this type of site:

- Only three of US EPA's seven examples were environmental dredging projects; the remainder were civil engineering/construction projects with completely different objectives. Civil engineering projects are intended to provide infrastructure improvements and are not selected in accordance with NCP and CERCLA objectives. The three environmental dredge projects were in water bodies that cannot reasonably be argued to be comparable to Lake Superior. In the open waters of Lake Superior, wind, wave, and ice action all pose the threat of causing sheet pile failure, particularly when the "dry excavation" must be left open over the course of years. Weston explicitly excluded external forces from its analysis "such as those due to wave and ice loading" (Weston, 2009, p. 6), which would make SED-6 even more prone to failure.
- One of the three environmental dredging projects cited in the ROD was unable to meet its Performance Standards and was stopped due to geotechnical stability concerns that are similar to those posed at the Ashland Site. "[C]omplete excavation of DNAPL-affected till was infeasible ***because of concerns about the stability of the sheet pile wall and breaching the lower aquifer***. In these areas, final confirmation samples typically were not collected, and the till was capped with 2 feet of imported clay" (US EPA Region V, 2007, p. 25; emphasis added).
- The other four are civil engineering projects, ranging up to $1.1 billion in cost, which required the installation of costly (> $50 million) coffer dams or where wet dredging technology was simply precluded as a viable remedial technology because consolidated bedrock had to be removed.

These projects are wholly inapplicable as reasonable precedent (Table 1).

**Table 1 Dry Dredging Case Studies Cited by US EPA Region V (2010)**

| Site Name | Location | Environmental Dredging?[a] | Significant Differences from the Ashland Site |
|---|---|---|---|
| Taconite Harbor | Cook County, MN | No | 1950s civil engineering construction project[a] into bedrock (conventional wet dredging was technically impracticable). |
| Eyemouth Harbor Development | Berwickshire, UK | No | Mid-20th century civil engineering construction project into bedrock (conventional wet dredging was technically impracticable). |
| Olmstead Lock and Dam, Ohio River | Olmsted, IL | No | $1.1 billion civil engineering construction project with $81 million coffer dams. |
| Montgomery Point Lock and Dam on White River | near Watson, AR | No | $245 million civil engineering construction project with coffer dam. |
| Velsicol Chemical Corp | St. Louis, MI | Yes | Riverine impoundment (dam pool). Unable to achieve Performance Standards due to geotechnical failure concerns. |
| Bryant Mill Pond, Kalamazoo River | Kalamazoo, MI | Yes | Man-made impoundments on a creek; no NAPL. |
| Newburgh Lake/River Rouge | Livonia, MI | Yes | Shallow riverine impoundment; no NAPL. |

Notes:
(a) The term "civil engineering construction project" refers to a project that was performed for infrastructure improvement (*e.g.*, installing a dam to create hydroelectric power) *versus* environmental dredging performed to remove contaminated sediments.
NAPL = non-aqueous phase liquid.

In contrast to SED-6, there is extensive precedent for the common use of wet dredge technology for environmental remediation, demonstrating its implementability. As expressed in the 2009 PRAP comments (pp. 32-35), this includes sites in US EPA Region V and sites contaminated with NAPL and PAHs. Further, over the last three decades of environmental dredging, a range of near- and far-field engineering and performance controls have been developed to minimize short-term environmental impacts, including control of NAPL releases (see PRAP comments at pp. 17-18), from wet dredging. Dry dredging is not a prerequisite to successful, environmentally protective remediation.

Similarly, CDF technology has been implemented successfully at sites comparable to the Ashland Site. Over the last 40 years, the United States Army Corps of Engineers (US ACOE) has disposed of over 90 million $yd^3$ of contaminated Great Lakes sediments in 45 CDFs that it constructed and/or operated (US ACOE, 2003). Of this amount, 70 million $yd^3$ were from designated "Areas of Concern."[13] Many of these projects included a cleanup component (*e.g.*, Saginaw, MI; Ashtabula, OH; East Chicago, IN) (US ACOE, 2003). As described by US ACOE (2003), a number of these CDFs have been constructed in Wisconsin, thus demonstrating precedent for this technology (see Table 2).

**Table 2 Examples of CDFs in Wisconsin**

| CDF Name | Beneficial Use[a] | Size (ac) | Size ($yd^3$) |
|---|---|---|---|
| Milwaukee Harbor | Ferry dock | 44 | 1,600,000 |
| Manitowoc Harbor | Recreational/park use | 24 | 800,000 |
| Kewaunee Harbor | Recreational use | 28 | 500,000 |
| Kenosha Harbor | Marina | 32 | 750,000 |
| Green Bay Harbor – Renard Island | Wildlife access | 60 | 1,200,000 |

Note:
(a) Current or anticipated.

Fact sheets prepared by US ACOE (2003) describing these CDFs are included as Attachment 2.

More detail on the precedent of the use of CDFs at comparable sites is included in a white paper prepared by Michael Palermo, Ph.D., to support the FS at the Ashland Site. The paper, titled, "Precedent Sites and Technical Considerations for Placement of CERCLA Sediments in Confined Disposal Facilities (CDFs)," is provided as Attachment 3 to this report.

Comparable large sediment sites with sediment DNAPL impacts (such as the nearby St. Louis River/Interlake/Duluth Tar [SLRIDT] Site in Duluth, MN,[14] and the Island End River (IER) Site in Everett, MA,[15] where both wet dredging and CDF technology were part of the selected remedy) or other sites referenced in the PRAP comments (at pp. 32-35) where wet dredging technology was implemented are conspicuously absent from US EPA's examples. This failure to address the complete picture of applicable precedents and comparable projects is further evidence that the ROD failed to evaluate competing sediment remedies objectively to arrive at the remedy that best complies with the NCP.

[13] A term defined by the US-Canada Great Lakes Water Quality Agreement as "geographic areas that fail to meet the general or specific objectives of the agreement where such failure has caused or is likely to cause impairment of beneficial use of the area's ability to support aquatic life."

[14] The SLRIDT Site is also a US EPA Region V site on Lake Superior (only about 60 miles from the Ashland Site) with DNAPL sediment impacts. According to the SLRIDT ROD, the wet dredging remedy component targeted 25 acres of contaminated sediment (approximately 224,000 $yd^3$), that would "be conducted using a technique that is designed to minimize dredge residual and resuspension of sediments" (MPCA, 2004, pp. 75-76).

[15] The IER Site is a state-led site with extensive DNAPL sediment impacts. Approximately 100,000 $yd^3$ of contaminated sediments were wet dredged from the IER and placed into an in-water low-permeability steel sheet-pile CDF (BBL, 2005).

## 4.3 SED-6 is Not Cost-effective

The objective basis for determination of cost-effectiveness is that costs are proportional to overall effectiveness (NCP 300.430(f)(1)(ii)(D); US EPA, 1996). According to US EPA guidance (1996, p. 5, emphasis in original): "Cost is a critical factor in the process of identifying a preferred remedy. In fact, CERCLA and the NCP require that every remedy selected must be cost-effective." Remedy alternatives, such as SED-6, may be "screened out" if they provide equivalent effectiveness and implementability as another alternative that is less costly (40 CFR 300.430(e)(7)(iii); US EPA, 1996, p. 4). As noted above, that is exactly the scenario presented by comparing SED-6 to SED-4 and SED-2 (see Table 3, below).

**Table 3 Relative Cost Comparison – SED-6 *versus* other Viable Alternatives (US Dollars, based on URS (2008) FS, -30/+50 expected accuracy)**

| Alternative | Description | Estimated Cost ($M) | Potential Cost Savings |
|---|---|---|---|
| SED-2 | Confined Disposal Facility | $35.8 | Up to $41.3 M |
| SED-4 | Wet Dredge | $45.3-64.7[a] | Up to $31.8 M |
| SED-6 | Hybrid Dredge | $63.3-77.1[a] | None |

Notes:
(a) Range based on different removal (hydraulic *versus* mechanical dredge) and treatment (landfill *versus* thermal treatment) technologies.

It is misleading for US EPA to imply that remedial cost estimates are equally cost-effective if they fall within the "-30/+50" range of each other (US EPA Region V, 2010, p. A-25). This range is intended to explain the expected accuracy of estimated *versus* actual costs (see US EPA and US ACOE, 2000, pp. 2-4 to 2-6), not the relativity of remedial alternatives cost estimates to each other. Based on information available at the time the ROD was issued, since SED-6 will cost substantially more and has significant safety and implementability concerns, SED-6 is clearly not cost-effective and should have been screened out from further consideration. Further, the "mitigation measures" raised by Weston, even if successful, would further raise the cost of SED-6 and render it even less cost-effective.

# 5 Both SED-4 and SED-2 are Protective and Comply with the National Contingency Plan

In contrast to SED-6, both SED-4 and SED-2 are protective alternatives that meet the other Threshold and Balancing remedy selection criteria.[16] Tables 4 and 5 present a summary of US EPA's Comparative Analysis between SED-6 and these two alternatives as described in the ROD. Tables 4 and 5 also describe the material flaws in this Comparative Analysis process and the outcome from an objective analysis/comparison.

## 5.1 SED-4 is a Viable Sediment Remedy Alternative

The apparent basis for selecting SED-6 over SED-4 is the concern that wet dredging would generate more sheen and residuals that would pose an unacceptable risk as compared to dry dredging. This appears to be the main reason behind US EPA's conclusion that SED-6 is a better option for the threshold criteria of overall protectiveness, as well as several balancing criteria, and it appears to have ultimately swayed US EPA's remedy alternative selection (US EPA Region V, 2010, pp. 66, 69-71).

However, concerns over sheen and dredge residuals are exaggerated. The intent of sediment remediation is mitigation of risk such that reasonably anticipated future land use can be supported. Either remediation activity (SED-4 or SED-6) will destroy ecological receptors (*e.g.*, benthic organisms) and their habitat in the short term. Residuals, which would be generated in either alternative, will be covered with a habitat restoration layer that would be monitored and maintained to prevent unacceptable long-term exposures. The migration of sheens generated during dredging can be controlled by implementing best management practices (BMPs), such as silt curtains.

It has not been demonstrated whether the sheens and residuals hypothetically produced during wet dredging would pose any risk to human health or the environment, let alone support selection of the SED-6 alternative. In contrast, the PRAP comments demonstrated that post-dredge residuals are not likely to pose an unacceptable risk under the SED-4 alternative. Sheen generation under current conditions is so sporadic that the sheens have not been successfully sampled to evaluate their composition, and surface water data do not demonstrate an unacceptable risk to human health. To compound the error, the elevated safety risks to workers and the community associated with SED-6 have been disregarded, which has the effect of diminishing its overall protectiveness (see PRAP comments at pp. 23-31), as described in Section 4.1. Further, even the reasonably anticipated future land use of the Site, as a marina and as a receiving water for stormwater, would release PAHs and hydrocarbons sheens to the remediated Bay.

Further, Performance Standards define the level of overall protectiveness, both during and after remediation, which must be met to ensure environmental protection. These Performance Standards must be met under either SED-4 or SED-6; consequently, both remedies offer equivalent protectiveness and effectiveness.[17]

[16] The Modifying Criteria are omitted here, but presumably both the State and Ashland community would accept a safer, quicker, less costly but equally protective remedy. The City has stated its preference for a safe, protective remedy in public comments to the PRAP (Monroe and Peterson, 2009).
[17] As described in Section 6, there remain significant technical issues associated with US EPA's sediment PRG that is used as the basis for sediment Performance Standards in the ROD.

## 5.2 SED-2 is a Viable Sediment Remedy Alternative

US EPA's apparent basis for eliminating the SED-2 alternative is State permitting concerns that are raised as a "threshold" ARAR compliance issue:

> [SED-2] cannot be permitted by [WDNR] under Section 30.12 [because it] would not follow the shoreline and would not meet the public interest standards. (US EPA Region V, 2010, p. 67)

US EPA also raised State permitting requirements as an implementability issue:

> WDNR has indicated that the Governor and Legislature must approve [the SED-2 alternative]…obtaining authorization to proceed is uncertain. (US EPA Region V, 2010, p. 71)

Yet this stated concern ignores precedent for the common use of CDFs throughout the world, throughout the Great Lakes, including in Wisconsin (see Table 2). Additionally, CDFs, in conjunction with wet dredging, have been used at DNAPL/PAH-impacted sites, such as the nearby, comparable SLRIDT Site in Duluth, MN, and also at the IER Site in Everett, MA. A CDF may also provide the opportunity to promote beneficial reuse of the Ashland waterfront for various recreational purposes, including marina use. Therefore, this alternative likely would be accepted by the Ashland community.

An additional ROD-stated concern (US EPA Region V, 2010, p. 68) for the SED-2 CDF alternative that it "would not result in a reduction in the toxicity, mobility, or volume." However, the SED-2 CDF alternative could be readily modified to treat and contain impacted sediments. For example, the CDF could incorporate design elements to reduce contaminant mass (*i.e.*, horizontal and vertical recovery NAPL extraction wells) or reduce toxicity and mobility (*i.e.*, the contained sediment mass could be permanently stabilized by amending it with cement or similar *in-situ* additives) to alleviate these concerns.

**Table 4 Comparative Analysis of SED-4 and SED-6 Alternatives**

<table>
<tr><th rowspan="2">Comparison Criteria</th><th colspan="3">Summary of ROD Comparative Analysis</th><th rowspan="2">Flaws in ROD Analysis</th><th rowspan="2">Superior Alternative - Objective Comparison</th></tr>
<tr><th>SED-4</th><th>SED-6</th><th>Superior Alternative</th></tr>
<tr><td colspan="6">Threshold Criteria</td></tr>
<tr><td>Overall Protectiveness</td><td>"could also be protective," but raises short-term effectiveness concerns (sheens and residuals) (p. 66).</td><td>"more protective" since NAPL release would be minimal (p. 66).</td><td>SED-6</td><td>-The ROD contains PS for control of "NAPL sheens and turbidity." SED-4 and SED-6 offer equal overall protectiveness given the requirement that both alternatives must meet the ROD's PS concerning sheens and turbidity.<br>-US EPA has not demonstrated that the presence of either sheens or residuals would pose a demonstrable threat to human health or the environment under either alternative.<br>-Short-term risk concerns with SED-4 are mitigated applying PS on the same basis that worker safety risks with SED-6 regarding short-term effectiveness criterion can be mitigated.<br>-SED-6 poses significant short-term risks that diminish its overall protectiveness.</td><td>SED-4</td></tr>
<tr><td>ARAR Compliance</td><td colspan="2">Alternatives "would be similar" (p. 67).</td><td>Comparable</td><td>N/A</td><td>Comparable</td></tr>
<tr><td colspan="6">Balancing Criteria</td></tr>
<tr><td>Long-term Effectiveness</td><td colspan="2">Both provide "highest effectiveness and permanence over the long term" (p. 68).</td><td>Comparable</td><td>N/A</td><td>Comparable</td></tr>
<tr><td>Reduction in Toxicity, Mobility, and Volume</td><td>"greatest degree of reduction" but "due to sediment residuals after removal via dredging…not as well as…SED-6" (p. 69).</td><td>"greatest degree of reduction," better than SED-4 due to fewer residuals generated (p. 69).</td><td>SED-6</td><td>-Remedy must meet protective PS regardless of implementation method. Therefore, net reduction is equivalent.<br>-ROD states: "Alternative SED-4, if selected as the sediment remedy in an ESD, would use the same [PS] and remedial approach as described in Sections 12.3 and 12.4 of this ROD."<br>-SED-6 remedy failure may mobilize contaminated sediments and the Copper Falls groundwater plume, increasing impacted volumes.</td><td>Comparable</td></tr>
</table>

| Comparison Criteria | Summary of ROD Comparative Analysis | | | Flaws in ROD Analysis | Superior Alternative - Objective Comparison |
|---|---|---|---|---|---|
| | **SED-4** | **SED-6** | **Superior Alternative** | | |
| Short-term Effectiveness | Concerns (volatile emissions, re-suspension) are common to SED-6 (p. 70). | -Dry excavation is "best method to quickly remove COCs and achieve protection."<br>-Acknowledges "increased concerns with worker safety," but claims they can be mitigated by unspecified "effective and reliable mitigative measures" (p. 70). | SED-6 | -Comparison does not state why SED-6 is "the best method." No rationale is provided.<br>-Summarily dismisses increased short-term risks to human health and environment associated with the SED-6 remedy.<br>-Short-term risks of SED-6 which are more severe than SED-4 include worker safety and exposure to airborne hazards and nuisance to the community. | SED-4 |
| Implementability | "more difficult" because of potential for re-dredging if PS not met (p. 71). | "difficult to implement" due to dewatering and stability concerns, and the need for engineering controls for volatilization (p. 71). | SED-6 | -Dismissive of stated concerns with SED-6 implementability.<br>-Ignores substantial wet dredge precedent. | SED-4 |
| Cost | Both alternatives are cost-effective (A-24 to A-26). | | Comparable | SED-6 has a disproportionally higher estimated cost without additional benefit since both alternatives would be required to achieve protective PS. | SED-4 |

Notes:
Source: US EPA Region V, 2010.
ARAR = Applicable or Relevant and Appropriate Requirement; COC = Contaminant of concern; ESD = Explanation of Significant Differences; N/A = Not applicable; NAPL = Non-aqueous phase liquid; PS = Performance Standards; ROD = Record of Decision; US EPA = United States Environmental Protection Agency.

**Table 5  Comparative Analysis of SED-2 and SED-6 Alternatives**

| Comparison Criteria | Summary of ROD Comparative Analysis | | | Flaws in ROD Analysis | Superior Alternative - Objective Comparison |
|---|---|---|---|---|---|
| | SED-2 | SED-6 | Superior Alternative | | |
| **Threshold Criteria** | | | | | |
| Overall Protectiveness | "assures protection of human health and the environment" (p. 66). | "protective" (p. 66). | Comparable | SED-6 poses significant short-term risks that diminish its overall protectiveness. | SED-2 |
| ARAR Compliance | CDF "cannot be permitted by [WDNR] under Section 30.12 [because it] would not follow the shoreline and would not meet the public interest standards" (p. 67). | "would be similar" to other dredging alternatives (p. 67). | SED-6 | Ignores CDF site precedent in WI (see Table 2) and throughout the Great Lakes. | Comparable |
| **Balancing Criteria** | | | | | |
| Long-term Effectiveness | Provides "moderate level of permanence and effectiveness over the long term" (p. 68). | "highest effectiveness and permanence over the long term" (p. 68). | Comparable | N/A | Comparable |
| Reduction in Toxicity, Mobility, and Volume | "would not result in a reduction in the toxicity, mobility, or volume" (p. 68). | "greatest degree of reduction" (p. 69). | SED-6 | -CDF would eliminate migration potential and therefore environmental mobility *via* containment.<br>-Design modifications such as NAPL recovery wells, would remove contaminant volume.<br>-Design modifications such as *in-situ* stabilization, would reduce mobility.<br>-CDF would reduce human and ecological exposures. | Comparable |

| Comparison Criteria | Summary of ROD Comparative Analysis | | | Flaws in ROD Analysis | Superior Alternative - Objective Comparison |
|---|---|---|---|---|---|
| | SED-2 | SED-6 | Superior Alternative | | |
| Short-term Effectiveness | "would have the least short-term impact" (p. 70). | -Dry excavation is "best method to quickly remove COCs and achieve protection."<br>-Acknowledges "increased concerns with worker safety," but claims they can be mitigated by unspecified "effective and reliable mitigative measures" (p. 70). | SED-2 | -Comparison does not state why SED-6 is "the best method." No rationale is provided.<br>-Summarily dismisses increased short-term risks to human health and environment associated with the SED-6 remedy. | SED-2 |
| Implementability | "technology and equipment…readily available…proven to be reliable at other similar sites" (p. 71), but "WDNR has indicated that the Governor and Legislature must approve…obtaining authorization to proceed is uncertain" (p. 71). | "difficult to implement" due to dewatering and stability concerns, and the need for engineering controls for volatilization (p. 71). | SED-2 | Ignores CDF site precedent in WI (see Table 2) and throughout the Great Lakes. | SED-2 |
| Cost | Does not describe overall cost effectiveness (simply states FS cost estimates). | | Comparable | SED-6 has a disproportionally higher estimated cost. | SED-2 |

Notes:
Source: US EPA Region V, 2010.
ARAR = Applicable or Relevant and Appropriate Requirement; CDF = Confined disposal facility; COC = Contaminant of concern; N/A = Not applicable; NAPL = Non-aqueous phase liquid; ROD = Record of Decision; WDNR = Wisconsin Department of Natural Resources.

# 6 US EPA Has Set Wet Dredge Performance Standards that are Unnecessarily Conservative and Technically Impracticable to Implement

## 6.1 The Wet Dredge Sediment Performance Standards are Unnecessarily Conservative

The ROD provision for a wet dredge pilot test is illusory because, strictly interpreted, the wet dredge Performance Standards set in the ROD are unnecessarily conservative and not achievable. (This would also likely to be the case under the SED-6 "dry dredge" scenario.) Yet, a more practical interpretation of these same wet dredge Performance Standards may still achieve a protective wet dredge remedy. The discussion below demonstrates why strict compliance with the wet dredge Performance Standards set in the ROD is not necessary to achieve a protective remedy.

US EPA concluded, based on the Ashland Site Baseline Ecological Risk Assessment (BERA) (URS, 2007a) that there are unacceptable risks to the benthic macroinvertebrate community ("benthics") from exposure to contaminated sediment at the Ashland Site, but not to other aquatic, avian, or upland species. Benthic habitat is limited to shallow (0-6 inches), not deep, sediments in what is referred to as the "biologically active zone."[18] PAHs in sediment were assessed to be the most significant contributor of potential ecological risk. As a result, a PAH threshold concentration for adverse effects in benthics was calculated to establish a sediment Preliminary Remediation Goal (PRG) as described in the Remedial Action Objectives Technical Memorandum (US EPA, 2007).

However, as described previously in NSPW's PRAP comments (pp. 3-10), there remain significant technical issues associated with the sediment PRG[19] that is used as the basis for sediment Performance Standards in the ROD. Specifically, US EPA is giving disproportionate weight to a subset of laboratory-based sediment toxicity studies and literature-derived information while disregarding results from the direct line of evidence – a benthics assessment conducted at the Ashland Site. The net result is a PRG and sediment Performance Standards that are overly conservative and will require a significantly larger remediation than is needed to protect ecological receptors at the Site.

The overly conservative nature of the PRG and sediment Performance Standards can be demonstrated as follows:

- The *estimated* organic carbon concentration used to develop the PRG is not representative of Site sediments, resulting in the overestimation of toxicity to benthics.
    - The sediment organic carbon concentration used to develop the PRG (0.415%; *i.e.*, mean of organic carbon content in sampling stations SQT1 and SQT7) represents only a small fraction (less than the $10^{th}$ percentile) of sediments at the Ashland Site. Site-specific sediment toxicity tests with woody sediments with a higher organic carbon content (*i.e.*, representative of the

[18] US EPA refers to the biologically active zone sediments as those occurring at 0-15 cm (or 0-6 inches) depth (US EPA Region V, 2010, p. 42).
[19] 2,295 µg PAH/g organic carbon (9.5 µg PAH/g dwt at 0.415% organic carbon).

majority of the Site) are not toxic to benthic organisms (URS, 2007a; SEH, 2002). Specifically, only around 10% of sediments at the Site are predicted to pose an unacceptable risk to benthics (*i.e.*, exceeding a 20% effect concentration, as shown in Figure 2).

- If the PRG is applied properly (*i.e.*, only to shallow sediments on an organic carbon-normalized basis), only a small fraction (10% or less) of the ROD-proposed sediment remediation volume would require remediation.
- Even though the results of a benthics survey were deemed inconclusive by US EPA,[20] the survey clearly demonstrated that severe impacts to the benthic community were not observed at the Ashland Site.

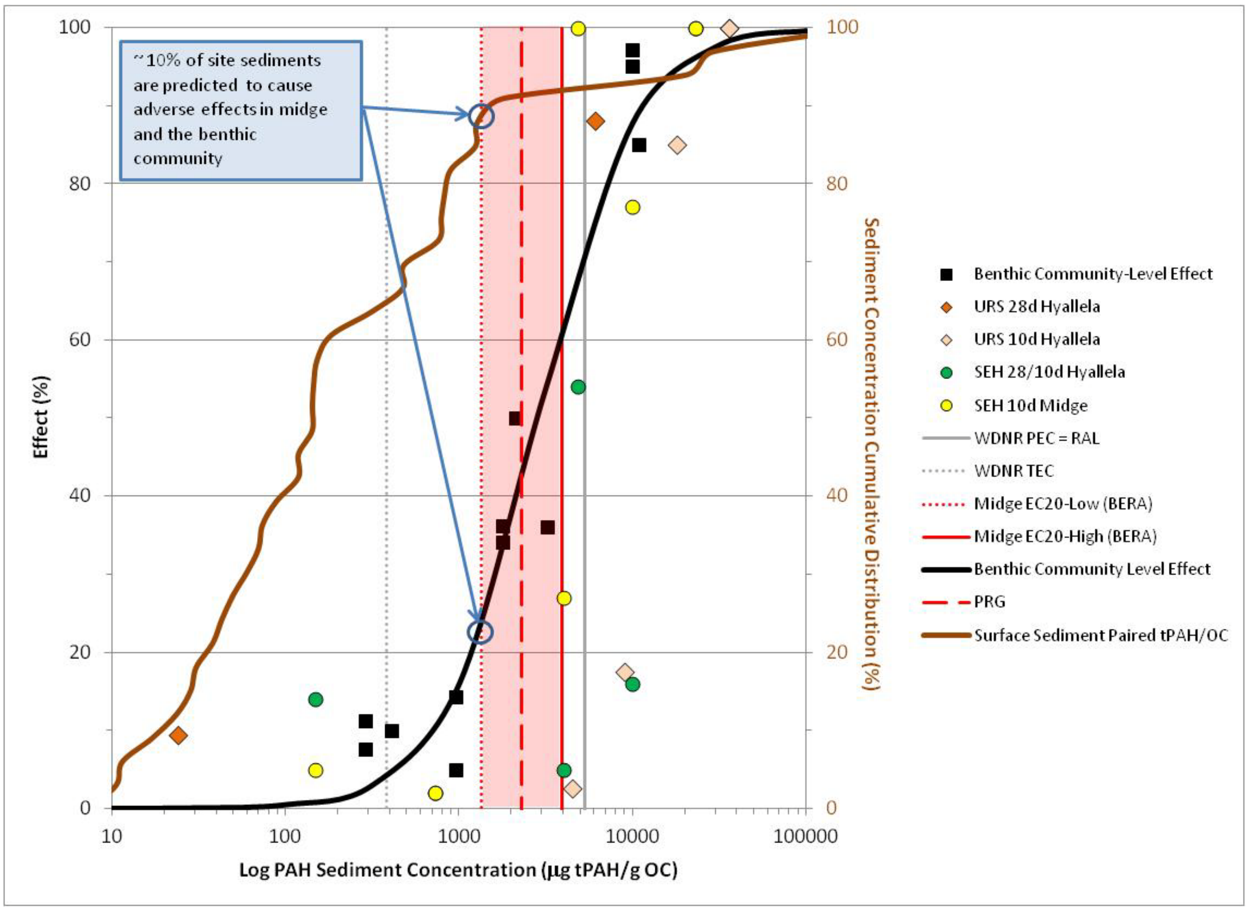


**Figure 2 Exposure and Benthic Invertebrate Effect Distributions for PAHs in Sediments at the Ashland Site**

Note: The brown line depicts a cumulative distribution of organic carbon-normalized total PAH concentrations occurring in surface sediment at the Ashland Site. The black line depicts a cumulative effect distribution for benthic invertebrates using benthic invertebrate PAH effect data published by Long *et al*. (1995), Persaud *et al*. (1993), Swartz (1999), Neff *et al*. (1986), and Swartz *et al*. (1995). The red shaded box shows the low- and high-end 20% effect concentration for midge as derived in the BERA. The figure shows that only approximately 10% of site sediments (cumulative distribution at approximately 90$^{th}$ percentile) have an organic carbon-normalized total PAH concentration that exceeds the 20% low-end effect concentration for midge. Similarly, only approximately 10% of Ashland site sediments have an organic carbon-normalized total PAH concentration that exceeds the 20% effect concentration for benthics as derived using published data in the scientific literature.

[20] "Effects observed from field surveys of the existing benthic community indicated effects that were less dramatic than those demonstrated in the laboratory toxicity studies, but interpretation of the field survey data is made very difficult by a high degree of variability and lack of comparability between reference and site stations" (US EPA Region V, 2010, p. 49).

Further, as reflected in the findings of the Human Health Risk Assessment (HHRA), based upon Chequamegon Bay data, there are no unacceptable human health risks to either a swimmer or wader from exposure to sediments or surface water (URS, 2007b, pp. 2-3):

> Risks to waders and swimmers (sediments)…are all within USEPA's target risk range of $10^{-4}$ to $10^{-6}$ for lifetime cancer risk and a target HI [hazard index] of less than or equal to 1 for non-cancer risk and are less than the WDNR threshold of $1x10^{-5}$ for lifetime cancer risk and a target HI of less than or equal to 1 for non-cancer risk.

However, at the request of WDNR, "hypothetical" human health risks posed by routine exposure to sporadic, uncharacterized "sheens" of an undefined nature and undefined source were calculated and presented in the PRAP and HHRA. These hypothetical human health risks associated with routinely contacting such sheens are unrealistic, technically unjustifiable, and not based on any sheen data.[21]

A more appropriate quantification of risks (presented in the PRAP comments, pp. 11-14) indicates that sheens are not expected to pose significant risk to human health; the appearance of a sheen has been so sporadic that it has never been successfully sampled. Indeed, as the HHRA correctly concluded (URS, 2007b, pp. 3, 6-7), the risks calculated for potential exposure to the sheen are highly uncertain, likely overestimated by several orders of magnitude (*i.e.*, by a factor of thousands), "and should not be used as the basis for deriving remedial action objectives." This uncertainty is so large as to render these risk estimates arbitrary and capricious in the context of actual data and conditions.

## 6.2 Applying the Performance Standards Developed for Shallow Sediments to Deep Sediments is Arbitrary and Capricious

Risks to benthic invertebrates from exposure to PAHs in the surface sediment were used to develop sediment Performance Standards. Consequently, the target depth for sediment remediation, as well as for post-remediation compliance, should be at the point where exposure to benthic invertebrates may occur. The vast majority of benthic invertebrates live in the biologically active zone of sediments, which corresponds to approximately the upper 6 inches or less.[22] Dredging will remove the current biologically active zone, after which a "habitat restoration layer" will be placed to fill in the lake bed topography and provide habitat for colonization by new benthic populations. Furthermore, as a measure of protectiveness, under a wet dredge scenario, the "cut line" would be set conservatively deep so as to over-excavate impacted material at depths greater than the existing biologically active zone.

After dredging, compliance with the benthic organism-based Performance Standards should be assessed in the habitat restoration layer – and not at the base of the dredge excavation or "cut line" – since the habitat restoration layer will become the new biologically active zone post-remediation and there will be no benthic organisms remaining at the cut line. As a result, compliance should account for the natural attenuation provided by the habitat restoration layer, even if it is not intended as a "cap." If, however, compliance sampling is to be performed at the cut line, it should be viewed as a level that affords the appropriate level of protectiveness in the biologically active zone. That is, the Performance Standard in the biologically active zone needs to account for natural attenuation provided by the restorative layer. If sampling indicates that compliance with an organic carbon-normalized Performance Standard is not

[21] In the absence of sheen chemical concentration data, hypothetical human health risks were calculated using two different estimates of chemical concentrations using 1) chemical concentrations from a tar sample collected from the deep Copper Falls aquifer beneath the MGP site; and 2) pure phase water solubility concentrations. Neither of these approaches is technically sound, as described in the PRAP comments (at pp. 11-14).

[22] US EPA refers to the bioactive zone sediments as those occurring at 0-15 cm (or 0-6 inch) depth (US EPA Region V, 2010, p. 42).

achieved at the cut line, native organic carbon can be augmented through placement of the restorative layer to ensure compliance with sediment Performance Standards. Similarly, the restorative layer can be engineered to remain in place ("armored") to prevent potential future exposure to residuals, as reflected in US EPA guidance (1998, 2005) on remediating contaminated sediments, and conditions can be monitored over time. As indicated above, the PRG upon which the Performance Standards are based is already set to be overly conservative, such that implementing an additional layer of conservatism to compliance assessment measures simply drives up remediation costs without the additional benefit of reducing ecological risk.

To summarize:

- Biologically based cleanup goals should apply in zones where those biota live (*e.g.*, benthics in shallow sediments). Following dredging, there will be no benthic organisms remaining at the cut line; hence, chronic or acute effects to benthic invertebrates from exposure to the generated residuals at the cut line are not a concern.
- The habitat restoration layer that is a required, integral part of the sediment remedy should not be arbitrarily ignored in developing and applying sediment Performance Standards.
- If compliance sampling is to be performed at the cut line, it should be statistically based such that the cleanup goal in the biologically active zone would be met on average, accounting for attenuation provided by the restorative layer.

## 6.3 Achieving a Performance Standard Where No Single Sample Exceeds 22 mg/kg Total PAH is Not Technically Practicable and Not Necessary to Achieve a Protective Remedy

The use of average target concentrations as Performance Standards has been adopted at numerous sites within US EPA Region V, including sediment-contaminated sites in Wisconsin, and it has been recognized by the National Research Council in *Sediment Dredging at Superfund Megasites* (NRC, 2007) as the appropriate basis for establishing chemical Performance Standards to achieve risk-based cleanup levels. Because sampling data by definition are finite and yield only an estimate of the average, surface-weighted average concentrations (SWACs) or other statistical methods are typically used to evaluate post-remediation compliance. At the Ashland Site, achievement of the cleanup goal as a SWAC in the biologically active zone will result in a successful remedy that provides long-term (chronic) protection to benthic invertebrates. The purpose of a SWAC approach is to avoid having one or more "outlier" samples drive the remedial action and associated costs. The application of a 22 mg/kg total PAH maximum would result in this value "controlling" the remedy, essentially obviating the SWAC approach.

# 7 Conclusions

In conclusion, Gradient analyzed the technical issues raised by Weston regarding the hybrid remedy selected by US EPA in the ROD and reviewed US EPA's Comparative Analysis in the ROD in light of the Weston Report. Based on this analysis, we conclude the following:

1. The SED-6 hybrid remedy selection is flawed due to insufficient consideration given to risks of basal heave, containment failure, piping, implementability issues, excessive cost, and increased worker and community safety concerns;
2. Weston's approach does not adequately acknowledge or protect against these risks;
3. The ROD Comparative Analysis is flawed because it did not adequately consider those failure mechanisms or define the proposed Weston modifications;
4. A proper Comparative Analysis, in which all technical information/precedent is considered, suggests either a SED-2 CDF or SED-4 wet dredge alternative should have been selected; and
5. The ROD provision for a wet dredge pilot test is illusory because, strictly interpreted, the wet dredge Performance Standards set in the ROD are unnecessarily conservative and not achievable. A more reasonable interpretation of these same wet dredge Performance Standards may still achieve a protective wet dredge remedy.

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# Attachment 1

**Kurt Herman's *Curriculum Vitae***

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## Areas of Expertise

Chemical fate and transport, non-aqueous phase liquids (NAPLs), hydrogeology, site characterization and remediation strategy, cost recovery and allocation, historical waste practices, former manufactured gas plants (MGPs), environmental liability cost estimation.

## Education & Certifications

M.Eng., Civil and Environmental Engineering, Massachusetts Institute of Technology, 2002.

Graduate Coursework in Subsurface Hydrology, University of Arizona's Department of Hydrology and Water Resources, 2000-2001.

B.A., Double Major in Economics and Geology, Miami University (Ohio), 1997.

Registered Professional Geologist No. G2184, Oregon.

OSHA 40-Hour Hazardous Waste Operations and Emergency Response (HAZWOPER) Certification; 8-Hour Refresher Certification (current through 2011).

## Professional Experience

2002 – Present GRADIENT, Cambridge, MA
Principal Scientist. Practice areas include hazardous waste site investigation and remediation; chemical fate and transport modeling and analysis; environmental liability cost estimation; forensic reconstruction of historical operations and releases; and cost recovery/allocation. Extensive experience with MGPs and DNAPLs. Environmental Science Team Manager (2009-2012). GIS Team Manager (2012). Editor of Gradient's *Trends* newsletter (2011-2012).

2000 – 2001 UNIVERSITY OF ARIZONA, Tucson, AZ
Research Assistant for National Institute for Environmental Health Sciences (NIEHS) Superfund Colloquium. Surface water modeling (stream-groundwater interaction) of an acid mine drainage-impacted Arizona creek.

1997 – 2000 SADAT ASSOCIATES, INC., Princeton, NJ
Environmental Scientist. Responsible for the investigation, characterization, and remediation of a wide range of hazardous waste sites (*e.g.*, MGP, petroleum, chlorinated solvents, inorganics).

## Professional Activities and Affiliations

- Sigma Xi – Scientific and Engineering Honorary, MIT Chapter. 2003-2012.
- American Society for Civil Engineers. 2002-2012.
- Peer Reviewer for *Soil and Sediment Contamination: An International Journal*. 2009-2012.
- 2010 Session Chair, "NAPLs – Plume Characterization and Remediation Strategies," Seventh Annual Conference, Remediation of Chlorinated and Recalcitrant Compounds. 2010.

## Projects – *Environmental Liability Cost Estimation*

Insurance Company: Served on an independent review panel to evaluate environmental reserve estimation procedures.

Prospective Purchaser: Developed cost estimates for contingent environmental liabilities associated with a clay mine in Brazil.

Utility Company: Prepared environmental liability cost estimates for a portfolio of sites using probabilistic cost modeling tools, including stochastic (Monte Carlo) methods. Incorporated cash flow modeling. Estimates prepared for regulatory disclosure.

Utility Company: Evaluated the need for and environmental liability costs associated with a US EPA-led time critical removal action for a former MGP site. Used probabilistic cost modeling techniques to develop a range of cost estimates for the proposed remedial actions in support of settlement negotiations.

Confidential Client: Evaluated technical aspects of a cost allocation proposal and applied financial modeling incorporating uncertainty in support of settlement negotiations.

Utility Company: Performed 3rd party review/critique of remediation cost estimates developed for a sediment Superfund site. Used in support of settlement negotiations.

Petroleum Company: Developed deterministic remediation cost estimates in support of divestiture of a bulk petroleum storage terminal in NYC.

Utility Company: Evaluated the basis for a proposed natural resource damage (NRD) settlement offer at a Great Lakes Superfund Site. Used benchmarking analysis techniques to quantitatively compare the proposed offer to NRD settlements at other sediment sites.

Utility Company: Critiqued the use of a probabilistic cost model to estimate remediation costs for a portfolio of MGP sites.

## Projects – *Cost Allocation & Cost Recovery*

Superfund Site Cost Allocation: Developed multiple PRP cost allocation involving former MGP and wood treating operations. Performed forensic evaluation of PAH/NAPL contaminant releases to sediment, including a source mixing model used for source apportionment.

Superfund Site Cost Allocation: Provided technical support in evaluating cost allocation issues at an industrial site in Oregon. Analyzed information regarding the nature and extent of contamination within the site and assessed factors that could be evaluated to apportion costs among potentially responsible parties.

Cost Allocation for 13 MGPs: Cost allocation between current utility successor and a former utility holding company for 13 MGPs. Examined the level of operator control at the plants and the impacts of releases from various time periods.

St. Thomas USVI Superfund Site: Insurance recovery litigation and cost allocation for a CERCLA site in the US Virgin Islands.

NCP Consistency of Response Actions at 8 MGPs, NY: Evaluated the National Contingency Plan consistency of environmental responses at 8 former MGP sites to evaluate CERCLA cost recovery claims. Evaluated remedial cost-effectiveness of selected/implemented alternatives.

Causation Analysis for MGP Cost Recovery: Evaluated the role of a former MGP in causing a persistent tar slick in an adjacent river.

Utility Company Cost Recovery/Allocation, NY: As part of a CERCLA cost recovery effort, assessed historical plant operations and contamination patterns to demonstrate the former owner/operator's role in causing the need for remedy.

MGP Cost Allocation: Determined the roles of several former owner/operators and plant demolition in historical operating practices that contributed to existing contamination and response costs. Developed allocation model.

MGPs, NCP Consistency Evaluation and Cost Allocation, NY: Evaluated environmental conditions and response actions for National Contingency Plan consistency as part of a cost allocation between former owners and operators. Critiqued cost-effectiveness of selected remedy alternatives as well as probabilistic liability estimates prepared for the sites.

MGP Cost Allocation, SC: Cost allocation between current utility successor and a former utility holding company at a South Carolina NPL Site (former MGP). Performed an engineering causation analysis to determine: 1) the extent of holding company control over historical operations; 2) the degree to which these historical operations led to contamination; and 3) this contamination's contribution to cleanup needs.

## Projects – *Due Diligence*

Large Chemical Plant, Elizabeth, NJ: Reviewed potential environmental liabilities for prospective purchaser redeveloping 100+ year chemical plant into a cogeneration facility. Evaluated pile design considerations to avoid contamination drag-down.

Beneficial Reuse Determination, Brooklyn, NY: Beneficial reuse determination (regulatory, physical, and chemical evaluation) of soils from various Newtown Creek industries as stabilized soil cap.

Multiple Municipal, Commercial, and Industrial Facilities, NY and NJ: Assessed potential environmental liabilities and evaluated baseline conditions at multiple properties pursuant to commercial real estate transactions (*e.g.*, ASTM Phase I and NJDEP Preliminary Assessments).

## Projects – *Reconstruction of Historical Operations and Waste Practices*

Northeast Utility Company: Testified as a 30(b)(6) witness regarding historical (c. 1900-1975) MGP and power plant operations, including waste handling, byproduct disposition, and decommissioning.

>30 MGPs, Multiple Projects, Nationwide: Researched and reconstructed historical operations and release history (1850-1960) and created conceptual fate and transport models at multiple MGPs in the context of expected/intended, causation, and timing/continuity issues for insurance cost recovery litigation.

Flare Maker: Evaluated the standard of care for perchlorate handling from c. 1956-1985 in the context of regulations, waste handling practices, and analytical capabilities during that time frame. Examined the issue of whether different practices should have been performed, given the state of knowledge and practice at the time.

Glassmaking Plant: Evaluated potential releases of arsenic during historic glassmaking operations *via* a mass balance approach. Examined the issue of whether different practices should have been performed, based on contemporaneous knowledge and practices.

Insurance Recovery for 260-acre Industrial Complex, MA: Evaluated standard of care and contamination causation/timing issues for environmental response cost recovery at a 260-acre industrial complex including an MGP site, a former coke plant, a tar refinery, and a blast furnace.

## Projects – *Site Characterization & Remediation*

Industrial Client, Portland, OR: Registered Geologist for RI/FS at an industrial site in Oregon. Petroleum hydrocarbon (LNAPL).

Superfund Site, Dover, DE: Extensive multi-media (DNAPL, soil, groundwater, soil gas) investigation of dry cleaning PCE released in a downtown residential/commercial area.

Superfund Site, Clifton, NJ: Multi-media chlorinated solvent (DNAPL) investigation, implementing a suite of DNAPL screening techniques (hydrophobic dye, centrifuging, OVA). Seepage pit closure.

Box Maker, Clifton, NJ: Fuel oil UST closure. Site investigation (soil, groundwater) of gasoline UST release. Remediation of gasoline impacts by chemical oxidation/bioremediation *via* oxygen release compound (ORC).

MGP, Hoboken, NJ: Expedited remedial investigation (soil, groundwater) of MGP site in urban area.

Auto Body Shop, Central NJ: Planned and directed remediation (excavation and removal) of chlorinated solvent-impacted soils. Implemented sampling protocol to confirm appropriateness of MNA as post-excavation groundwater remedy.

Alloy Metal Distributor, Secaucus, NJ: Site investigation of fuel oil impacts (soil, groundwater).

Pharmaceutical Manufacturer, Argentina: Conceptual design for risk-based remedy (dual-phase extraction) for soil and groundwater contamination (VOCs included acetone, toluene, and chlorinated solvents).

Industrial Client, NJ: Planned and directed multimedia (soil, groundwater, surface water, sediments, wetlands) investigation of an ammonia plume impacting a potable aquifer and discharging to surface water (lake and wetlands).

Sediment Study, NY/NJ: Planned and directed sediment core study to assess chemical and physical feasibility of reusing sediments dredged from the Arthur Kill as stabilized soil cap at a Brownfields site.

Brownfields Site, Woodbridge, NJ: Site investigation (soil, sediments, wetlands) for Brownfields redevelopment suitability determination at 290-acre historic fill and active rail facility site. Metals, pesticides, and herbicides.

Prosthetic Limb Manufacturer, Meadowlands, NJ: Site investigation (overburden and bedrock soil and groundwater) of VOCs.

Bulk Oil Storage Terminal, Staten Island, NY: Site investigation (soil, groundwater, LNAPL) of bulk oil storage terminal with extensive LNAPL (diesel, fuel oil, gasoline) contamination.

Warehousing and Distribution Facility, Jersey City, NJ: Site investigation (soil, groundwater, LNAPL) of No. 6 fuel oil release.

Rail Spur, Jersey City, NJ: Site investigation (soil, sediment, wetland) of rail spur/historical fill area. Herbicides, pesticides, and metals.

Fragrance Manufacturer, Edison, NJ: Remedial investigation (soil, sediment, groundwater) of historical waste disposal operable units, including buried drums, seepage pits, and solid waste disposal areas.

Landfill Investigation, Secaucus, NJ: Site characterization of former municipal landfill for potential Brownfields reuse.

## Publications/Presentations

Herman, KD; Wannamaker, EJ; Jegadeesan, GB. 2012. "Sediment PAH Allocation Using Parent PAH Proportions and a Least Root Mean Squares Mixing Model." *Environmental Forensics* 13:3.

Herman, KD. 2012. "Environmental Liability Cost Estimation (ELCE) at MGP Sites." Presented to the MGP Consortium, Savannah, GA, January 25.

Herman, KD. 2011. "Chemical Profile: Molybdenum." Presented at EPRI P40 Summer Meeting, Asheville, NC, July 12.

Principal Investigator for EPRI Report 2011815. *Chemical Constituents in Coal Combustion Products: Molybdenum.*

Herman, KD. 2011. "Remedy Sustainability: Is the Cure Worse than the Disease?" *Gradient Trends – Risk Science & Application* 50:6.

Herman, KD; Bittner, AB. 2010. "How Much Tar is in the Mud? – Reducing Uncertainty in Characterizing the Distribution and Mass of DNAPL In Sediments." Presented at the EPRI MGP 2010 Symposium, San Antonio, TX, January 28.

Wannamaker, EJ; Herman, KD; Butler, EL; Petito Boyce, C; Jakubiak, J. 2010. "Subsurface LNAPL Behavior in a Tidal Zone: A Case Study." Presented at the Seventh International Battelle Conference, Remediation of Chlorinated and Recalcitrant Compounds, Monterey, CA, May 27.

Herman, KD. 2009. "Sediment DNAPL challenges." *Gradient Trends – Risk Science & Application* 45:5.

Herman, KD; Bittner, A. 2008. "Reducing Uncertainty in DNAPL Characterization." Presented at the 24th Annual International Conference on Soils, Sediments, and Water, Amherst, MA, October 23.

Wannamaker, EJ; Bittner, AB; Butler, EL; Herman, KD; Jakubiak, J; Petito Boyce, C. 2009. "Mobility of Subsurface LNAPL in a Tidal Zone: A Case Study." Presented at the 2009 Geological Society of America Annual Meeting, Portland, OR, October 21.

Herman, KD. 2008. "A Standardized Method to Interpret Field Observations of MGP NAPL." Poster presented at the 18th Annual AEHS Conference, March 11.

Herman, KD. 2007. "Who pays for cleanup costs?" *Gradient Trends – Risk Science & Application* 38:1.

Langseth, DE; Herman, KD. 2006. "Liability estimation frameworks" *Gradient Trends – Risk Science & Application* 36:3.

Herman, KD. 2002. "Basin-scale modeling of nutrient impacts in the Eel River Watershed, Plymouth, Massachusetts." by Kurt D. Herman. Thesis (M.Eng.). Massachusetts Institute of Technology, Dept. of Civil and Environmental Engineering.

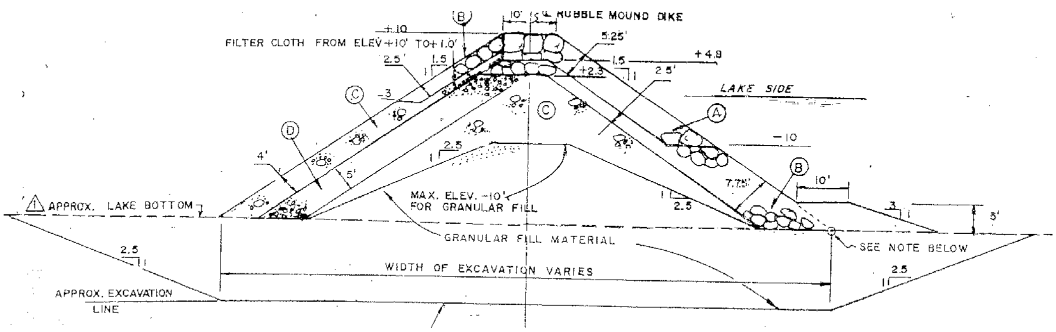
Herman, KD. 2000. "Metal Removal in the Hyporheic Zone in a Mining Contaminated Stream in Arizona." Presented to NIEHS Superfund Colloquium, Tucson, AZ, December.

# Attachment 2

**Examples of Confined Disposal Facilities in Wisconsin**
**(US ACOE, 2003 Fact Sheets)**

# MILWAUKEE HARBOR
# CDF Fact Sheet

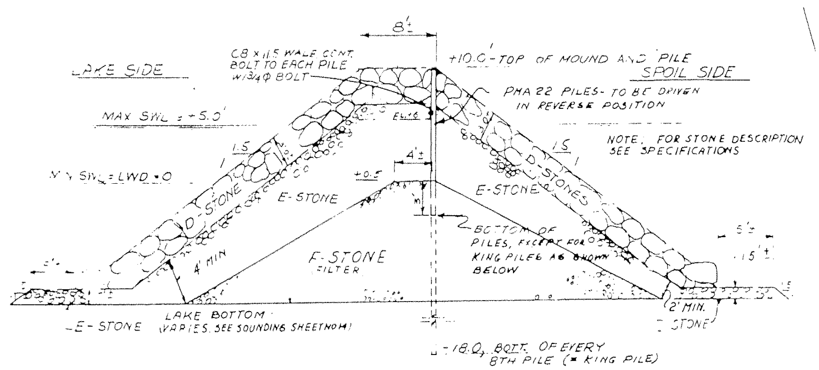
- Milwaukee Harbor CDF is an in-water facility in Milwaukee, Wisconsin, located at the south end of Milwaukee Harbor.
- Navigation project served: Milwaukee Harbor.
- Local sponsor is the City of Milwaukee.
- CDF area: 44 acres with a total capacity of 1,600,000 $y^3$; available capacity is 336,000 $y^3$
- EIS completed April 1972: "Milwaukee Diked Disposal Area, Wisconsin"
- Constructed in 1975 at a cost of $5,963,000.
- Dike design is a graded stone with sand filter and coverstone on granular fill; south dike steel pile bulkhead. Grout mattresses installed against the interior faces of the north and east dikes in 1986.




- Material placed in CDF by hydraulic and mechanical dredging.
- Dewatered by seepage through dikes and discharge through filter cells to Lake Michigan.
- Effluent treated by primary settling and filtration in dike core and filter cells.
- Water quality monitoring of wells in dike and filter cell Dye tracer test conducted in 1984.
- Post-closure use intended for ferry dock.

# MANITOWOC HARBOR
## CDF Fact Sheet

- Manitowoc Harbor CDF is and in-water facility in Manitowoc, Wisconsin, extending north from the north breakwater at Manitowoc Harbor at the mouth of the Manitowoc River.
- Navigation projects served: Manitowoc Harbor.
- Local sponsor is the City of Manitowoc.
- CDF Area: 24 acres; 800,000 $y^3$ total capacity; 408,000 $y^3$ available capacity.
- EIS completed in December 1974: "Maintenance Dredging & Disposal, Manitowoc Harbor, Wisconsin"
- Constructed in 1975 at a cost of $4,147,000 million.
- Dike design is rubble mound with steel sheet pile cutoff wall and filter stone core covered by additional stone layer and armorstone. Sandy dredged material placed at dike areas in where dye tracer study showed excessive flows.

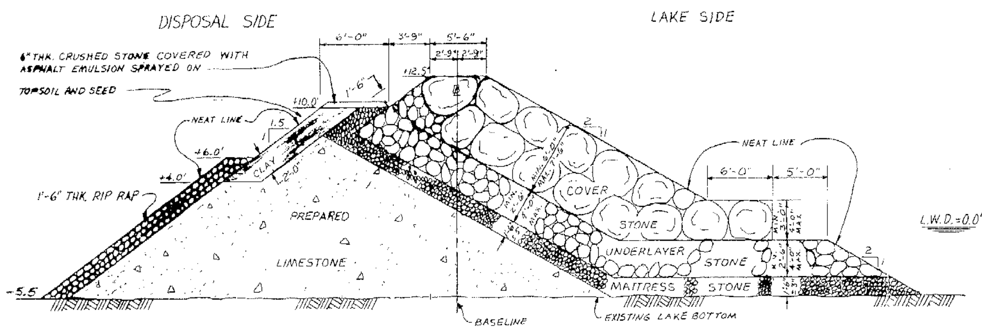



TYPICAL RUBBLE MOUND SECTION A - A

- Material placed in CDF by mechanical and hydraulic dredging.
- Dewatered by seepage through dike and discharge through filter cells to Lake Michigan.
- Effluent treatment by primary settling and filtration in dike core and filter cells.
- Water quality monitoring during disposal operations of dredge discharge, ponded water inside CDF, wells in dike walls, mixing zone, and open water site. Dye tracer test conducted in 1984.
- Post-closure use will be recreation/park.

# KEWAUNEE HARBOR
# CDF Fact Sheet

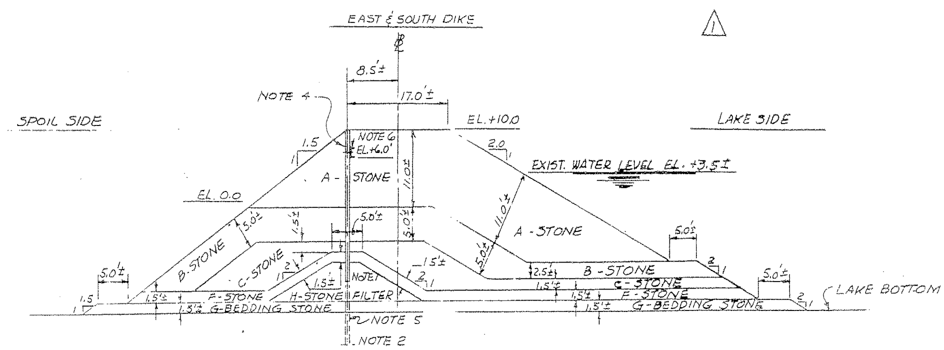
- Kewaunee Harbor CDF is an in-water facility in Kewaunee, Wisconsin, located on Lake Michigan adjacent to the shore and breakwater, north of Kewaunee River.
- Navigation project served:  Kewaunee Harbor.
- Local sponsor is the City of Kewaunee.
- CDF area:  28 acres with a total capacity of 500,000 $y^3$; 130,000 $y^3$ capacity remaining.
- EIS completed November 1974: “Kewaunee Harbor, Wisconsin – Maintenance Dredging & Confined Disposal Dredge Disposal”
- Constructed in 1982 at a cost of $2,017,000.
- Dike design is a prepared limestone core with coverstone and rip-rap for wave protection.   Sand and stone placed at dike areas in 1984 where dye tracer study showed excessive flows.




- Material placed in CDF by mechanical and hydraulic means.
- Dewatered by seepage through dike and discharge through filter cells to Lake Michigan.
- Effluent treated by primary settling and filtration in dike core and filter cells.
- Water quality monitoring during disposal operations of dredged discharge, ponded water inside CDF, 3 wells in dikes, mixing zone, and open water site.  Dye tracer study conducted in 1984.
- Post-closure use intended for recreation.

# KENOSHA HARBOR
# CDF Fact Sheet

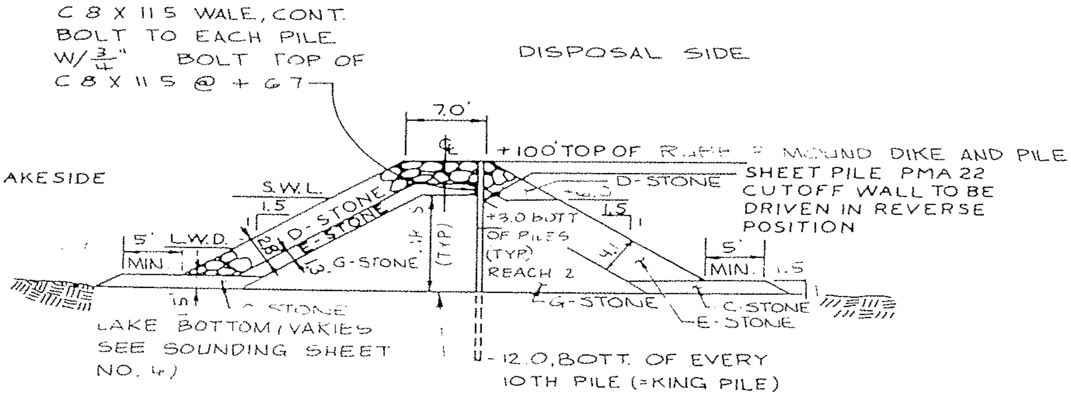
- Kenosha Harbor CDF is an in-water facility in Kenosha, Wisconsin, located in Lake Michigan south of the mouth of Pile Creek.
- Navigation project served: Kenosha Harbor.
- Local sponsor is the City of Kenosha.
- CDF area: 32 acres with a total capacity of 750,000 $y^3$; no capacity remaining.
- EIS completed March 1974: "Maintenance Dredging & Combined Disposal Area, Kenosha, Wisconsin"
- Constructed in 1975 at a cost of $8,270,000. Last disposal operation in 1987.
- Dike design is rubblemound with sheet pile cutoff wall and graded filter core.




- Dredged material placed in CDF by mechanical means.
- Dewatered by seepage through dikes to Lake Michigan.
- Effluent treated by primary settling and filtration in dike core.
- Water quality monitoring during dredging operations of dredge discharge, ponded water inside CDF, 3 dike wells, mixing zone, and open water site.
- The unfilled facility was transferred to the sponsor, who modified it for use as a marina.

# GREEN BAY HARBOR - RENARD ISLAND
# CDF Fact Sheet

- Renard Island (also known as Kidney Island) is an in-water facility in Green Bay, Wisconsin, located south of the mouth of the Fox River.
- Navigation project served: Green Bay Harbor
- CDF area: 60 acres with a total capacity of 1,200,000 $y^3$; filled to capacity.
- EIS completed November 1977: “Operations & Maintenance Dredged Material Disposal at Green Bay Harbor, Wisconsin”
- Constructed in 1979 at a cost of $5,565,000; last disposal in 1996.
- Dike design is graded stone core with layered stone cover and sheet pile cutoff wall.




- Material was placed in CDF from hopper dredge by pipeline. After facility became filled, mechanically dredged material was placed by hopper and slide.
- Dewatered by seepage through dikes and discharge through filter cells to Green Bay.
- Effluent treated by filtration in dike core and filter cells.
- Water quality monitoring during disposal operations of dredge discharge, ponded water inside CDF, wells in dike walls, mixing zone, open water sites. Special studies include contaminant effects on birds, a plant survey, and evaluations of composting and beneficial use.
- Post-closure use currently for wildlife access. Additional uses undetermined.

# Attachment 3

**White Paper: "Precedent Sites and Technical Considerations for Placement of CERCLA Sediments in Confined Disposal Facilities (CDFs)" by Michael Palermo, Ph.D.**

# White Paper:
# Precedent Sites and Technical Considerations for Placement of CERCLA Sediments in Confined Disposal Facilities (CDFs)

Prepared by Michael R. Palermo
Mike Palermo Consulting, Inc.

## Introduction

The Ashland NSP/Lakefront Superfund Site consists of land and sediment located along the shore of Lake Superior, in Ashland, Wisconsin. Soils, groundwater and sediments at the site are contaminated with tar-derived volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs).

URS is currently conducting a Feasibility Study (FS) for the site. One option for managing the contaminated sediments under consideration is construction of a diked nearshore confined disposal facility (CDF) adjacent to the site. The CDF would be constructed partly on land and partly in-water and would cover the majority of offshore contamination and provide storage for additional sediments to be removed by dredging. As part of the FS process, URS wishes to define the extent of similar CDF usage for sediment remediation projects and technical considerations that may be applicable for this sediment management approach.

This white paper describes the use of CDFs for placement and confinement of contaminated sediments from remediation projects, precedent CDF sites in the U.S. and worldwide, and technical considerations for design and operation of CDFs for sediment remediation.

## CDFs as Sediment Remedy Components

A CDF is an engineered structure consisting of dikes or other structures that extend above any adjacent water surface and enclose a disposal area for containment of dredged material, isolating the dredged material from adjacent waters or land (USACE/USEPA 1992/2004). CDFs are one of the most commonly considered alternatives for contaminated sediments from navigation projects and are also an option commonly considered, and more recently used for disposal of contaminated sediments dredged for purposes of sediment remediation (USACE 2003 and USEPA 2005).

CDFs have been constructed for navigation dredged material since the 1950s. Most of the early CDFs were constructed using earthen dikes and were located in close proximity to navigation channels. Some of the early CDFs were not engineered, but merely constructed or upgraded for use by contractors as a part of a specific dredging contract (Murphy and Ziegler 1974). However, some of the early CDFs (e.g., the 2500-acre Craney Island nearshore site in Norfolk, Virginia) were rigorously engineered and have been in use for decades.

By the 1960s, sediment contamination was recognized as an issue for the nation's navigation dredging program, especially in the Great Lakes. Public Law 91-611 authorized a program for the confined disposal of contaminated sediments from federal navigation projects in the Great Lakes, and the USACE subsequently constructed and/or operated 45 CDFs (to include upland, nearshore and island sites) to manage over 90 million cubic yards of contaminated sediments dredged from Great Lakes harbors and channels. This same legislation authorized the initial USACE research program on dredged material assessment and management, which included efforts related to design and management of CDFs.

Design of CDFs has evolved over the years based on research and field experience. CDFs have combined design features and processes common to wastewater treatment, landfills, dams, and breakwaters. The designs for existing CDFs in the Great Lakes focused primarily on retention of sediment solids and physical stability of the dikes in the high-wave and ice-prone environment of the Great Lakes. In-water CDFs in the Great Lakes (e.g., the Duluth-Superior Harbor CDF) have dikes that resemble a breakwater, made of stone, gravel and other materials. Large armor stone is typically placed on the outside face of the dike to protect against wave attack. The inner core of the dike is often constructed with sand and gravel, sometimes in discrete layers. The dike, which is permeable, encircles the disposal area where the dredged material is placed. The sediment particles and contaminants bound to the particles settle out in the disposal area and excess water passes back through the dike. As the facility becomes filled, the dikes become less permeable, and water must be removed by overflow weirs, filters in the dikes, or is pumped. Upland CDFs are designed with earthen dikes that resemble a levee or berm. The dikes are most often constructed with soil excavated from the disposal site, and the sides seeded to prevent erosion (Miller 1998).

Development of a comprehensive technical basis for CDF design aspects related to management of contaminated sediments began in the mid-1970s with the USACE research programs initially authorized by PL 91-611. These efforts included evaluation of sedimentation and consolidation processes in CDFs; weir design; CDF effluent and leachate control; equipment and techniques for dewatering and reclamation; and beneficial reuse of material in CDFs. The first technical guidance for designing, constructing, and managing (CDFs) to maximize service life and minimize adverse environmental impacts were developed (Palermo and Poindexter 1978), and this guidance was subsequently updated and expanded in the USACE Engineer Manual *Confined Disposal of Dredged Material* (USACE 1987).

The knowledge base on CDFs expanded in the 1980s and 1990s, with more focus on contaminant pathways and evaluation of contaminant control measures for CDFs. Studies included development and verification of procedures for predicting contaminant mobility in CDF effluent, surface runoff; leachate to groundwater; volatilization to air; and mobility to upland plants and animals (Palermo and Engler 2002).

USACE and USEPA subsequently developed a Technical Framework for dredged material management (USACE 1992/2004) that included full consideration of CDF contaminant transport pathways and controls, and developed a supporting sediment testing manual that provided detailed testing and evaluation procedures for CDF contaminant pathways (USACE 2003). An expanded Engineer Manual *Dredging and Dredged Material Management* (USACE in publication) has also been developed that will include guidance on design of contaminant control measures for CDFs.

CDFs have also been adopted internationally as a sound management approach for contaminated sediment disposal, with many large-scale CDF projects constructed in both Europe and Asia. The Permanent International Association of Navigation Congresses (PIANC), developed technical guidance for CDFs that is applicable to both navigation and remediation projects that included the technical approaches developed by the USACE and USEPA (PIANC 2002).

Collectively, these developments provide a comprehensive technical basis for design of CDFs used for placement of contaminated sediments resulting from both navigation and sediment remediation projects.

Field experience and the availability of technically-based design procedures for CDF contaminant pathway evaluations and controls has led to increased consideration and use of CDFs for a number of sediment remediation projects. As a result, EPA recognized CDFs as an option for disposal of contaminated sediments at CERCLA sites and the knowledge base developed for design of CDFs for this purpose in its Superfund Sediment Guidance (USEPA 2005):

> "CDFs are engineered structures enclosed by dikes and specifically designed to contain sediment. CDFs have been widely used for navigational dredging projects and some combined navigational/environmental dredging projects but are less common for environmental dredging sites, due in part to siting considerations. However, they have been used to meet the needs of specific sites, as have other innovative in-water fill disposal options, for example, the filling of a previously used navigational waterway or slip to create new container terminal space (e.g., Hylebos Waterway cleanup and Sitcum Waterway cleanup in Tacoma, Washington). In some cases, new nearshore habitat has also been created as mitigation for the fill.
>
> For CDFs, contaminants may be lost via effluent during filling operations, surface runoff due to precipitation, seepage through the bottom and the dike wall, volatilization to the air, and uptake by plants and animals. The USACE has developed a suite of testing protocols for evaluating each of these pathways (U.S.

> EPA and USACE 1992), and these procedures are included in the ARCS program's *Estimating Contaminant Losses from Components of Remediation Alternatives for Contaminated Sediments* (U.S. EPA 1996). The USACE has also developed the [CDF] *Testing Manual* (USACE 2003), which describes contaminant pathway testing. Depending on the likelihood of contaminants leaching from the confined sediment, a variety of dike and bottom linings and cap materials may be used to minimize contaminant loss (U.S. EPA 1991c, U.S. EPA 1994d, Palermo and Averett 2000). Depending on contaminant characteristics, CDFs for sediment remediation projects may need control measures such as bottom or sidewall liners or low permeability dike cores. Project managers should also be aware that permeability across these barriers can decline significantly with time due to the consolidation process and blockage of pore spaces with fine materials. Therefore, site-specific evaluation is important."

As can be seen from the quote above, there are no prescriptive design features for CERCLA CDFs in the EPA guidance. This is appropriate, since a CDF for a CERLCA project would be designed based on the ARARs adapted for the project and sediment-specific and site-specific considerations.

## CDF Precedent Sites for Sediment Remediation

A review of the readily available literature and web resources was conducted to identify precedent CDF sites used for purposes of sediment remediation. Table 1 summarizes the locations, and readily available information on volumes, surface areas, filling operations and contaminant control measures for a total of 29 CDFs used for placement of sediments from remediation projects. A large number of additional CDFs have been used for placement of contaminated sediments from navigation dredging projects (with a number of CDFs used for highly contaminated dredged sediments), but these CDFs were not included in the summary in Table 1. Note also that none of the sites listed in Table 1 are licensed landfills, but there are several sites listed in Table 1 that are upland CDFs. A total of 22 of the CDFs are in-water nearshore or island sites, with many constructed by enclosing berths, slips, or areas adjacent to other confining structures such as breakwaters (similar to the proposal for the Ashland-NSP site). These include several CERCLA projects in the Seattle/ Tacoma, WA area to include: Blair Waterway, Milwaukee Waterway, and Eagle Harbor CDFs. The Waukegan Harbor site is a similar nearshore CERCLA CDF created by enclosing 3 acres of Lake Michigan waters by a sheet pile wall structure. The Menominee River site in Marinette WI is similar to the Waukegan Harbor site in that approximately two acres was enclosed by a sheet pile structure. As part of a project very similar in design to what is being proposed for the Ashland site, the Hamilton Harbor, Canada CDF will be constructed as a nearshore CDF for disposal of contaminated sediments from Hamilton Harbor, a project conducted under the Canadian Cleanup Fund (similar to the U.S. CERCLA program). Several other sites in Table 1 are placements of contaminated sediments from remediation projects in existing CDFs in the Great Lakes. These placements were made in dedicated cells constructed within the larger existing CDFs.

In addition to the CDFs actually used for remediation placements to date, several large CDFs are now in the feasibility or design stages for large-scale CERCLA sediment remedies. These include the Onondaga Lake, NY upland CDF that would enclose a 160 acre site for placement of over 2.3 million cubic yards of contaminated sediment and two large nearshore CDFs, the Terminal 4 CDF site that would be created by enclosure of a 14 acre slip on the Willamette River near Portland, OR, and the Consolidated Slip CDF that would be created by enclosure of a 4 acre berthing area in the Port of Los Angeles.

These precedent sites represent a range of sediment characteristics and site conditions and contribute to an ongoing and potentially increasing experience base for use of CDFs as sediment remedy alternatives, including construction of nearshore CDFs in coastal, riverine and lake environments.

## Regulatory Considerations for CDF CERCLA Placement

**USACE/ USEPA Technical Framework.** Just as there are no prescriptive design features for CERCLA CDFs, there are no prescriptive interpretations of regulatory requirements in the EPA Superfund Sediment Guidance (EPA 2005). Under CERCLA, no “permits” are required for on-site activities, however, the adoption of Applicable or Relevant and Appropriate Requirements (ARARs) for a CERCLA project brings with it a requirement to meet the substantive requirements of the regulations, standards, or criteria deemed applicable for the project. The USACE and EPA have jointly adopted a regulatory approach for CDFs based primarily on the Clean Water Act, since the principal contaminant pathways for a CDF are related to potential releases to surface water and such discharges are specifically identified in the CWA regulations (USACE/ USEPA 1992 (revised 2004); and USACE 2003).

For upland CDFs, there is potential for release to groundwater , and for this reason, some regulatory agencies have viewed CDFs in the same light as a permitted landfill under RCRA. However, for in-water CDFs there is little potential for groundwater impacts, and a regulatory approach based on the Clean Water Act is more technically appropriate. The USACE/USEPA Technical Framework for dredged material management (USACE/ USEPA 1992, updated 2004) (referred to here as the Technical Framework) is proposed here as an appropriate framework for evaluation and regulation of the CDF proposed for the Ashland project. Considerations for adopting this regulatory framework for in-water CDFs are provided in the following paragraphs.

Regulation of CDFs has evolved beginning with the passage of National Environmental Policy Act (NEPA) of 1969 and subsequent regulations and the development of the joint agency Technical Framework. The goal of the Technical Framework with respect to CDFs is to ensure that consistent, predictable, and reliable regulatory practices are employed when contaminated sediments are proposed for disposal in CDFs.

Disposal of dredged material in inland, near-coastal, and ocean waters has a clear regulatory basis. The discharge of dredged material into waters of the United States is regulated under the Clean Water Act. Waters of the United States subject to the Clean

Water Act are defined in 33 CFR Part 328 and 40 CFR 230.3(s). The CWA states that any "discharge of dredged or fill material into the navigable waters" would be regulated.

The regulatory path for disposal of dredged material in CDFs is not as clear. However, both the CWA and NEPA provide strong mandates for regulation of contaminated sediment placement in CDFs, to include placement of sediments from remediation projects. The discharge of return flow (effluent and surface runoff) to waters of the United States is specifically defined as a dredged material discharge under the CWA (Section 1.6.1). Under NEPA, the direct, indirect, and cumulative impacts associated with an action that may significantly affect the environment (Section 1.6.1) must be evaluated; therefore the Technical Framework requires that the potential environmental impacts associated with all aspects of CDFs to include potential releases of contaminants from all pathways must be evaluated and contaminant pathway controls incorporated into the design as needed.

**Clean Water Act.** The CWA, specifically Section 404 (b)(1), requires the development and application of environmental guidelines covering a broad range of effects to human health and ecological systems. The 404(b)(1) Guidelines (referred to here as the Guidelines) are at 40 CFR 230 and contain a number of evaluation provisions applicable when proposing dredged material disposal in CDFs. Section 230.10(b)(1) prohibits the disposal of dredged material that might violate applicable water quality standards, after consideration of disposal site dilution and dispersion. This provision is aimed at the effluent or runoff discharges from the CDF. That same section requires consideration of "effects on municipal water supplies" and is reinforced at Section 230.50. This section specifically addresses municipal and private water supplies including groundwater, which is a potential concern for the CDF leachate pathway. Section 230.11(h) requires consideration of a broad range of secondary effects from proposed dredged material discharges. Exposure pathways from a CDF such as plant or animal uptake could be considered secondary effects under this section. Other sections of the Guidelines address methods to minimize adverse effects at CDFs, such as the use of chemical flocculants to enhance deposition of suspended particulates, or treatment to neutralize contaminants. Other potential actions at CDFs suggested in CFR Section 230.72 include liners to reduce leaching, cover crops to reduce erosion, and containing discharged material to prevent point and non-point sources of pollution. Many of the compliance measures of the 404 (b)(1) Guidelines are aimed at protecting ecological and human health from proposed dredged or fill material discharges into waters of the United States. The Guidelines do not focus on CDFs nor do they exclude use of the Guidelines to capture potential contaminant releases from CDFs. Instead, the Guidelines take a common sense approach to potential contaminant releases from proposed dredged material discharge activities.

The CWA regulatory mandate for CDF effluent and runoff discharges is very specific. The discharge of effluent from a CDF is defined as a dredged material discharge in 33 CFR 323.2 (d) and 40 CFR 232.2 (e):

> "The term 'discharge of dredged material' means any addition of dredged material into waters of the United States. The term includes, without limitation, the addition of dredged material to a specified discharge site located in waters of

> the United States and the runoff or overflow from a contained land or water disposal area.
>
> In addition, Section 401 of the Clean Water Act provides the States a certification role as to project compliance with applicable State water quality standards; effluent limitations may be set as a condition of the certification. For purposes of the USACE regulatory program 'The return water from a contained disposal area is administratively defined as a discharge of dredged material by 33 CFR 323.2(d) even though the disposal itself occurs on the upland and thus does not require a Section 404 permit.' "

**Resource Conservation and Recovery Act (RCRA).** One of the purposes of RCRA is to ensure that generated waste "should be treated, stored, or disposed of so as to minimize the present and future threat to human health and the environment." Since April 1988, with publication of the USACE maintenance dredging and disposal regulations at 33 CFR 335-338, the USACE has asserted that dredged material is not a hazardous waste and should not be regulated under RCRA (Federal Register Vol. 53, No. 80, April 28, 1988, pages 14903 and 14910). Throughout the 1990's, the USACE made a concerted effort to demonstrate that the CWA/MPRSA protocols provided a level of environmental protection commensurate with that accorded under RCRA. Based on that demonstrated experience, the EPA excluded dredged material as a hazardous waste on 30 November 1998, providing the dredged material is regulated under either the CWA or MPRSA (Federal Register Vol. 63, No. 229, November 30, 1998). The effective rule date was 1 June 1999. Specifically, 40 CFR 261.4 of that rule provides that dredged material regulated under "a permit that has been issued under Section 404 of the Federal Water Pollution Control Act (33 U.S.C. 1344) or Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972 (33 U.S.C. 1413) is not a hazardous waste." The term permit also applies to congressionally authorized Civil Works projects undertaken by the USACE using the CWA or MPRSA regulatory regimes. The RCRA exclusion for dredged material only applies to activities permitted under either the MPRSA or CWA.

**Volatile Emissions.** Volatile emissions may be of concern for dredged material containing high concentrations of volatile organic contaminants. Volatile emissions from dredged material in CDFs are not regulated under the Clean Air Act (CAA), since the CAA regulates point and mobile sources. CDFs are neither. In most cases, air quality is regulated under the CAA only for gaseous emissions that could be sampled from a waste stream, not for volatilization from an areal source. Air quality from areal sources is more typically regulated, considering the resulting quality at a point of compliance or at the nearest receptor. Moreover, there have been no documented CAA concerns with any CDF anywhere in the nation. However, the Occupational Safety and Health Administration (OSHA) air quality standards apply when workers are exposed to inhalation or dermal contact with vapors while handling and managing dredged material containing certain volatile organic compounds in CDFs. When volatile emissions are of concern, evaluations may be performed and predicted emission concentrations compared to OSHA standards to determine compliance.

**Applicability of Technical Framework.** The joint USACE/USEPA Technical Framework developed for dredged material is especially relevant to in-water CDFs used for sediment remediation. Under the Technical Framework, a CDF can be designed to be as environmentally protective as a hazardous waste landfill under RCRA, with contaminant control measures (e.g. liners, covers, and impermeable dike sections) designed for the project-specific sediment characteristics and site conditions. This Technical Framework has been applied to a number of precedent sites, to include those used for CERCLA placement in the Great Lakes region.

## Considerations for CDF Design for CERCLA Placement

A CDF intended for placement of sediments from a CERCLA project would require design evaluations for both the conventional engineering aspects such as dike design and physical containment of the dredged sediments and control measures related to the potential contaminant migration pathways of concern for the site. Descriptions of the various technical evaluations that would potentially be required for a CDF intended for CERCLA placement are presented in the following paragraphs.

## Dike and Containment Design

Retaining dikes for a CDF should be designed considering geotechnical stability. For in-water CDFs, the dikes should also be designed to resist erosive forces due to currents and/or wave action. Episodic flood or storm events should be factored into the design. In-water CDFs in the Great Lakes region should also be designed to resist ice scour. These design aspects can be addressed with conventional geotechnical and coastal engineering evaluations.

The dike design for stability considerations should also be closely coordinated with the storage capacity and contaminant pathway evaluations. Specific design features for the main retaining dike may be required for contaminant pathway control.

## Solids Retention and Volumetric Capacity

When contaminated sediments are hydraulically placed in a CDF, the design, operation, and management of the site should be carefully managed to ensure retention of the sediment solids within the CDF (especially during active filling operations). This includes aspects relating to both the volume required for effective sedimentation for hydraulic placement and the storage capacity of the site. Procedures for such evaluations are presented in Engineer Manual 1110-2-2-5027 *Confined Disposal of Dredged Material* (USACE 1987). These design procedures will determine the surface area and ponding depth required to achieve effective sedimentation, the required containment volume for storage (including required freeboard), and the proper sizing of weir structures. The evaluations are based on results of column settling tests conducted to determine the zone, flocculent, and compression settling behavior of the sediments.

## Contaminant Pathway Evaluations

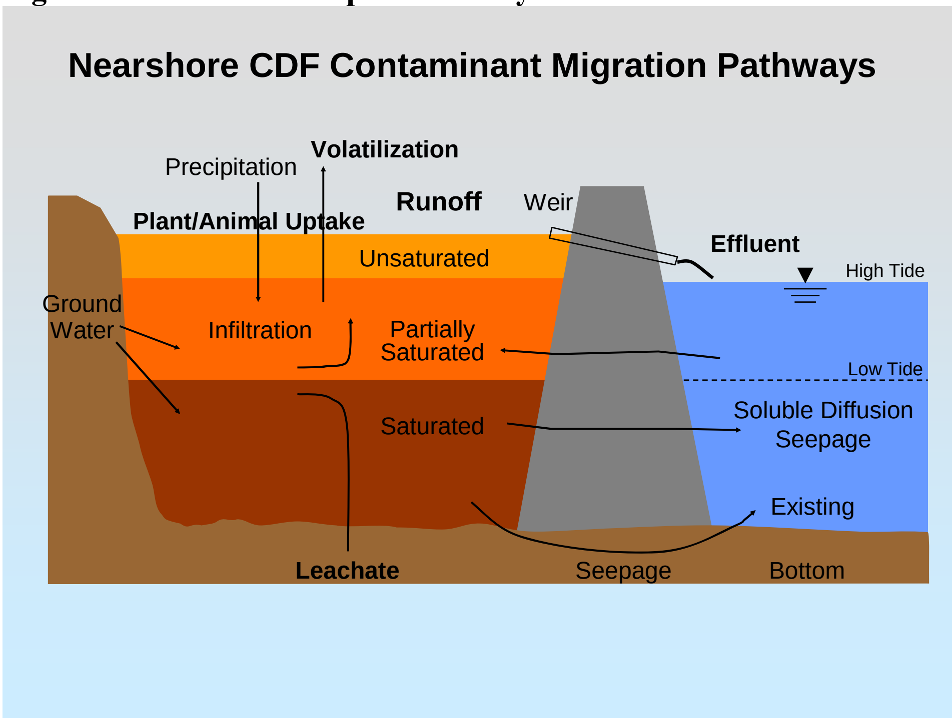
If contaminated sediments are placed in a CDF, consideration of pathways for migration of contaminants from the site and potential contaminant impacts may be required. Contaminant migration pathways are routes by which contaminants may move from the sediments placed within the CDF into the environment outside the site. The possible pathways from a nearshore CDF are illustrated in Figure 1. These pathways are:

- Effluent discharges to surface water during filling operations and subsequent settling and dewatering, to include displacement of water as material is placed within the site.
- Precipitation surface runoff.
- Leachate into groundwater or through dikes to surface water (to include movement via fluctuating water levels).
- Volatilization to the atmosphere.
- Direct uptake by plants and animals living on the dredged material and subsequent cycling through food webs.

A primary advantage of a nearshore CDF is that contaminated dredged material may remain within the saturated zone so that anaerobic conditions prevail and contaminant mobility is minimized. A potential disadvantage is water level fluctuation via water level changes or other mechanisms, which cause a pumping action through the exterior dikes, if the dikes are constructed of permeable material. The pumping action may result in soluble convection through the dike in the partially saturated zone and soluble diffusion from the saturated zone through the dike. The potential for such pumping action can be controlled by constructing the dikes with impermeable cores or cutoff walls.

A suite of evaluation procedures and laboratory test procedures has been developed by the USACE to evaluate CDF contaminant pathways. These procedures are presented in detail in *Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities - Testing Manual* (commonly called the Upland Testing Manual or UTM even though it equally applies to island or nearshore CDFs) (USACE 2003). From a technical standpoint, the procedures in the UTM are equally applicable to both navigation dredging and contaminated sediment remediation projects. The UTM presents both screening procedures to determine if a contaminant pathway is potentially an issue for a specific situation, and detailed testing and evaluation procedures to apply if needed.

**Figure 1. Potential Transport Pathways from CDF.**




Evaluations can be conducted using a tiered approach in the UTM, with the initial tiers as screening based on sediment contaminant concentrations of the materials to be placed in the CDF. Contaminant pathway tests in later tiers would determine if contaminant controls should be included in the CDF design.

## CDF Contaminant Control Measures

If applicable environmental standards or guidelines are not met for one or more of the contaminant pathways, contaminant control measures can be considered to reduce impacts to acceptable levels. Control measures may consist of treatment of sediments or pathway releases or operational or engineered containment features (USACE/USEPA 1992, updated 2004; Palermo and Averett 2000).

Containment in a CDF may be defined as an operational approach or engineered feature intended to function as a contaminant control measure to reduce the migration or transport of contaminants via one of the pathways. Containment refers to the ability of the site with associated features to hold the contaminants within the site as opposed to treatment approaches intended to destroy or degrade contaminants or immobilize the contaminants within the sediment. Contaminant measures may include operational modification, selective placement of dredged material, and engineered site controls or containment features, such as liners, surface covers, and lateral cutoffs

**Operational Controls.** Site operations can be used as a control measure for CDFs to reduce the loss of contaminants through the surface water, volatilization, and groundwater pathways. Operational controls may include selective placement of layers of clean and contaminated material to provide for attenuation or containment of contaminants (sandwiching); taking advantage of the fine-grained nature of dredged material, which yields low permeability when subjected to consolidation in a CDF (self-sealing or self-lining); placing cleaner dredged material with suitable chemical and physical properties as the final layer in a CDF (defacto surface covers); placement of drainage layers to enhance dewatering and consolidation; and control of ponded water to reduce hydrostatic head or maintain a negative hydraulic gradient (conditions causing seepage flow into the CDF as opposed to flow from the CDF).

Selective placement configurations with respect to water levels are possible for nearshore and in-water CDFs. Selective placement below the groundwater or surface water elevation keeps that portion of the CDF fill anaerobic, which reduces the potential for release of some classes of contaminants of concern (especially metals) to the dissolved phase.

**Self-Sealing of Fine-Grained Sediment.** The self-sealing or self-lining properties of fine-grained dredged material should be fully considered in evaluation of the need for engineered containment for leachate control. Dredged material is initially pumped into CDF at high water content, but quickly settles to a condition approaching in situ bulk density. With time, the newly placed material begins to consolidate. Measured permeabilities of dredged material at 50 percent of primary consolidation range from 8.5 x $10^{-10}$ to 4.1 x $10^{-7}$ cm/sec (Bartos 1977). This permeability is comparable to that required for liners in licensed solid waste landfills (1 x $10^{-7}$ cm/sec). Therefore, the initial layers of a fine-grained dredged material selectively placed in the bottom layers of a CDF will begin to "self-seal" as consolidation progresses, especially as more layers of dredged material are placed over the older layers.

**Engineered Controls.** Engineered CDF containment features or control measures are specifically designed and constructed to enhance containment of the dredged material and control potential contaminant release pathways. Containment features are not widely practiced for dredged material management because simply retaining sediment solids in a CDF has adequately met regulatory requirements for most navigation dredging projects. However, CDFs are often recommended and have been required for some sites receiving highly contaminated material or for sites located in environmentally sensitive areas. For these CDF's engineered features may be needed. The major categories of engineered containment features include bottom and sideliners (with and without leachate collection) surface covers, dike cores, and cutoff walls.

## CDF Monitoring

Any CDF used for placement of contaminated sediments will require monitoring to ensure that pathways are controlled both during the construction and filling operation and in the long term. In most cases, effluent will be monitored by sampling during filling operations. If the CDF includes an engineered cover, the pathways for surface runoff and direct uptake by organisms will be controlled and should not require long-term monitoring. Depending on the dike design, monitoring wells in the dike and/or around the CDF perimeter may be required, with periodic monitoring for leachate releases.

## Summary

This white paper has addressed a number of factors associated with the potential use of a CDF for storage of contaminated sediments at the Ashland NSP/Lakefront Superfund Site including:

- Early CDFs, including many in the Great Lakes, were designed prior to development of technical approaches for control of contaminant pathways. CDFs used for placement of sediments from remediation projects should be designed to account for potential contaminant pathways and designs should include measures for contaminant pathway control as needed.

- There are numerous precedent CDF sites used for placement of sediments from remediation projects; this precedent includes CERCLA projects in the Great Lakes region.

- There is no prescriptive requirement under CERCLA to adopt a given regulatory approach (e.g. RCRA) as an ARAR. A well-established Technical Framework has been developed by USACE and USEPA for CDFs under the CWA and NEPA. This Technical Framework is especially relevant to in-water CDFs. A CDF can be designed to be as environmentally protective as a hazardous waste landfill under RCRA, with contaminant control measures (e.g. liners, covers, and impermeable dike sections) designed for the project-specific sediment characteristics and site conditions.

- Standardized technical procedures are available for engineering design of CDFs and for evaluation of CDF contaminant pathways and contaminant controls.

- Contaminant controls, to include both operational controls and engineered controls such as covers and liners, can be incorporated into the design of CDFs when needed. Such controls can be designed to be environmentally protective and serve as effective sediment remedy components for CERCLA projects.

- Monitoring programs for CDFs ensure that pathway controls are effective both during construction and operations and in the long-term.

- In-water CDFs will have impacts with respect to loss of water surface area, but in many cases the water area lost is already impacted by contamination. Further, water loss impacts can be mitigated, and, in most cases, the resources can be mitigated with improved resources as compared to pre-project conditions.

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**Table 1.  Summary of Precedent CDF Sites Used for Sediment Remediation**

| | Project Name and Location | Project Type | Area and/or Volume | Dike and Containment Features | Filling Operations | Comments | References |
|---|---|---|---|---|---|---|---|
| | **GREAT LAKES** | | | | | | |
| 1 | Kinnickinnic River/ Milwaukee Harbor WI | Great Lakes Legacy Act; cellfor disposal of contaminanted sediment within larger Island CDF; in planning stages | 25 acres; 175 k cy | a cell within the CDF is planned; will dig within the CDF and raise the dikes;; will not require a liner;  10-11 ft deep over about half of the CDF | | | David Bowman, USACE Detroit District |
| 2 | Black Lagoon/ Point Mouille MI | Great Lakes Legacy Act; cell within larger Island CDF for disposal of contaminanted sediment; in planning stages | 110 k cy; 15 acres | EPA built cell within the R. river cell at Point Mouille Island CDF; pushed up dikes and clay liner; site was capped | mixed in lime and CalCement in scow; offloaded scow; placement also by trucks | Overall CDF 700 acre site designed for navigation material | POC: Dave Bowman, USACE Detroit District; EPA Mark Tuckman |
| 3 | Waukegan Harbor; Waukegan, IL | CERCLA Remedial Action; Nearshore CDF | 3 acres; 38 k cy | Slip 3 closed off by constructinmg double sheet pile wall retaining dike with sand and bentonite mix fill;slurry wall around sides of slip; spread 6 ft sand surcharge over top with clamshell; after 2 years, placed RCRA cap – HDPE and sand; bottom was hardpan with positive GW flow; so no liner required; pumping once a year for a few weeks to maintain a negative head; | pumped from upper harbor 50 -500 ppm | Material > 500 ppm PCB was taken to incineration; This is the best example of an in-water CDF constructed solely for CERCLA; | Tim Harrington; EPA RMP Kevin Adler |
| 4 | Menominee River, Marinette WI | RCRA Corrective Action; In water CDF | ~ 2 acres | Slip 8 closed off by surrounding it with sealed sheet piling. Filled to near grade and asphalt cap. | | | Weldon Bosworth, URS |
| 5 | Saginaw Bay CDF, MI | NRDA settlement ; sediments from outside nav channel; | 10-15 acres | Pushed up berms to create dedicated cell for disposal of contaminanted sediment within existing island CDF; | mechanical dredging with Cable Arm and conventional clam; | Saginaw CDF –  GM was PRP, Det Distrcit was being sued; under negotiated settlement; | David Bowman, USACE Detroit District |
| 6 | Hamilton Harbor – Randle Reef, ONT | Great Lakes Sustainability Fund (Canada); Nearshore/In-water CDF | 9.5 ha; 640k m3 | | | CDF very similar to what we propose. Construction scheduled to begin 2009 | http://www.harbourwest.com/_pdf/2004/041126-ScopingDocumentFinal.pdf; |
| 7 | Thunder Bay, ONT | Cleanup; Nearshore CDF | 81 ha; 21,000 m3 | | | | |
| 8 | Collingwood Harbour ONT | Environment Canada; Nearshore CDF | 8000 m3; 30,000 m2 estimated | CDF capped with clean sediment; | Demonstration project using Pueuma Pump; | | http://www.ijc.org/php/publications/html/cases/studies.html |
| 9 | Grand Calumet River | RCRA Corrective Action; Upland CDF | 55 acres750 k cy | Partial liner on inside of dikes; CAMU; is being pumped into again since additional sediment required dredging; built upland on an old unconfined dm site; | Hydrualic filling | PAHs; 750k cy; TSCA cell with isolation wall; 55acres; liners with leaks; capacity remaining; will be filled before capping; | Tim Harrington; |
| | **US SITES** | | | | | | |
| 10 | Long Slip Canal NJ | Cleanup: Nearshore CDF | 190,000 cy and covered 4.6 acres | CDF constructed by sealing the open end of the canal. | | This CDF provided remediation (isolation) of contaminated sediments in the canal | |
| 11 | Ted Williams Tunnel MA | Navigation/ Cleanup; Nearshore CDF | 4 ha; 89Kcy of contaminated seimdent | Upland CDF; lined; material stabilized | | | http://www.pbworld.com/library/technical_papers/pdf/42_ContaminatedSedimentCDF.pdf |
| 12 | Ft McHenry/Seagirt Terminal | Navigation/ Cleanup; Nearshore CDF | 59 ha, 3.5 MM cy capacity 600K cy contaminated | | | | http://www.pbworld.com/library/technical_papers/pdf/42_ContaminatedSedimentCDF.pdf |
| 13 | Wycoff Eagle Harbor (West Harbor Operable Unit) | CERCLA; Nearshore CDF | 1 acres | Sediments confined below raised GWT; HDPE liner; 1.5 m clean soil and asphalt cap; | Materials placed in CDF by front-end loaders | | WODCON 1998 paper |
| 14 | Thea Foss Waterway/ St. Paul Waterway, Tacoma, WA | CERCLA; Nearshore CDF | 13.6 acres; 646kcy | CDF constructed by diking off upper St. Paul WW; | Hydraulic dredging; | | WEDA 2000 paper |
| 15 | Sitcum/Milwaukee Waterway Commencement Bay | CERCLA; Nearshore CDF | 327k cy | CDF constructed by diking off upper Milwaukee WW; Berm constructed of native sediments and structural fill; Capped and converted to marine terminal | Dredging in Sitcum WW; combination of mechanical and hydraulic dredging; | PCBs; PAHs; metals | http://www.smwg.org/Puget%20Sound%20Workshop/Case%20Study2-Sitcum.pdf |
| 16 | Middle Waterway/ Blair Waterway; Tacoma WA | CERCLA; Nearshore CDF | 108k cy; | CDF constructed by diking off Blair WW Slip 1; | Clamshell dredging; barge placement via notched dike; | PAHs, Hg, Metals; | WEDA 2004 paper |
| 17 | Southwest Slip; Port of Los Angeles, CA | Nearshore CDF; Navigation | 25 acres; 1Mcy | CDF constructed by diking across slip in LA Harbor | Partial fill by barge via notched dike; hydraulic fill for completion; | | |
| 18 | Consolidated Slip/ Berth 243-245; Port of Los Angeles, CA | CERCLA; Nearshore CDF | 4 acres (approx) | Plans call for CDF to be constructed by diking off Berths 243-245 at POLA; CDF will be capped; | Filling planned by barge via notched dike and mechancial rehandling for final fill; | | |
| 19 | Terminal 4; Port of Portland, OR | CERCLA Non-Time Critical Removal Action; Nearshore CDF; in 60% design | 14 acres; 700k cy projected capacity | Berm will enclose across the mouth of an existing slip in the Willamette River; impermeable cap; | | PAHs, PCBs, Pesticides, metals, and TBTs; site will be used for additional placements for Willamette River CERCLA site River mi 2 to 11; | POC: Krista Koehl 503 944 7062; see paper in Battelle Savannah |
| 20 | Pointe Comfort/ Lavaca Bay, TX | Lavaca Bay – built upland CDF in the interior of a 375-acre Dredge Island | | | | Hg and PAH contamination (former chlor-alkali plant) The dredged material has been placed in the CDF, but the CDF is still open. | |
| 21 | Onondage Lake, NY | CERCLA; Upland CDF; presently in Remedial Design | 160 acres; 1.2M cy | Diked CDF build atop Solvay wastebed; liner and cap planned; | Hydraulic fill planned | Highly contaminated sediments; PAHs, Hg, volatiles; | ROD; consent decree |
| 22 | Island End River; Chelsea, MA | Cleanup; Nearshore CDF | | | Parsons old  info: HON is one of PRPs, MGP/Coal Tar site. Spoke with M. Crystal - Nearshore CDF, filling of CDF to begin in June with stabilization of "cut-off" waste.  Dredging scheduled to begin in July | Island End River trib of Mystic River; in Boston Chelsea MA – private project, Sevenson was contractor; built steel sheet containment, made a fill; coal tar; has pic on Sevenson calendar; | Mark Otis |
| 23 | New Bedford Harbor (Hot Spot Operable Unit); New Bedford, MA | CERCLA; Nearshore CDF | 7600 cy | Syntheic liner; synthetic cover for volatiles control; | Hyraulic fill; | PCB, High concentration | Weldon Bosworth, URS |
| | **WORLDWIDE SITES** | | | | | | |
| 24 | Parrot's Beak, Rotterdam, Netheralands | Upland CDF; navigation and cleanup | 40 ha; 1.5 M m3 | clay liner; clay dike core | Hydraulic filling | | PIANC 2002; WES TN-DOER-C18 |
| 25 | Ijsseloog, Lake Ketelmeer, Netherlands | Large Island CDF; navigation and cleanup; | 21M cy; | Clay bottom liner placed by hydraulic methods; operational controls | Hydraulic filling | | PIANC 2002; WES TN-DOER-C18 |
| 26 | Minamata Bay, Japan | Nearshore CDF; cleanup | | Surface Cover | | This is the well-known "Minimata Disease" site; Hg | PIANC 2002; WES TN-DOER-C18 |
| 27 | Takamatsu Harbor | 2 Nearshore CDFs; cleanup | 63k m3 | Sheetpile wall containment | Mechanical dredging with solidification prior to placment | | PIANC 2002 |
| 28 | Tresse Island, Venice Italy | Reconstructed island landfill | | Liner; cover; sheetpile cutoff walls; | | | WES TN-DOER-C18 |
| 29 | Geuzenhoek, Belgium | Upland CDF; navigation/ cleanup | 500k m3 | HDPE liner; slurry wall; leachate collection; | | | WES TN-DOER-C18 |

# ATTACHMENT 2-C

# Technical Assessment of EPA's Comparative Analysis of Near-Shore Dry Excavation and Site-Specific Failure Mechanisms

**Prepared for**

## Northern States Power Company
## Eau Claire, Wisconsin

**October 2012**

**Project No. 60012**

**Prepared by**


**Burns & McDonnell Engineering Co., Inc.**

**With Subconsultants**

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**NewFields**
**Hartman Associates LLC**
**Mike Palermo Consulting, Inc.**

## SIGNATURES

The following environmental professionals provided significant contributions in the development of this report, entitled "*Technical Assessment of EPA's Comparative Analysis of Near-Shore Dry Excavation and Site-Specific Failure Mechanisms*", dated October 2012 and prepared by the Burns & McDonnell team.

Project Manager, Matt Cox, PE - Burns & McDonnell

Senior Environmental Engineer, Margaret Kelley, PE - Burns & McDonnell

Additional Environmental Professionals contributed to the development of this report. Complete qualifications for the Burns & McDonnell team and the individuals are included in Appendix B.

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# 1.0 OVERVIEW

The remedy selection process for sediment at the Ashland/ Northern States Power (NSP) Lakefront Site (Site) has resulted in a Record of Decision (ROD) that relies on a dry excavation approach for near shore sediments. The Environmental Protection Agency's (EPA's) support for dry excavation is based on the comparative analysis in the ROD, the Proposed Remedial Action Plan (PRAP) and an evaluation of basal heave using Site-specific data presented in Weston's November 20, 2009 *Technical Memorandum Conceptual Geotechnical Assessment for Sediment Removal*(Weston memo). Refer to Appendix A for a summary of the timeline and activities that led to the development and inclusion of the Weston memo into the Administrative Record for the Site.

## 1.1. PURPOSE

This report assesses the near shore, dry excavation portion of sediment alternative SED-6, as defined in the ROD and included as part of EPA's Preferred Remedy (also referenced as the "hybrid remedy" and/or "dry excavation" in this report), and provides the Burns & McDonnell team's comments on behalf of Northern States Power Wisconsin (NSPW) in response to Weston's memo. Although Weston's memo addressed sheet pile design, upheaval of the excavation bottom surface, excavation bottom stability, and an evaluation of seepage gradients, this critique is primarily focused on the failure mechanism of basal heave. In addition, because the stated objective of the Weston memo was to evaluate "other failure mechanisms that could pose a potential risk to workers, the environment, and to the successful completion of the project", this report also enumerates additional near shore dry excavation failure mechanisms that were not discussed by Weston but should have been to accomplish the stated objective. The purpose of this report is to respond in detail to Weston's evaluations and raise these additional Site-specific failure mechanisms that were not identified by Weston and thus not fully considered in EPA's comparative analysis as presented in the ROD. Refer to Appendix B for a description of the members and qualifications of the Burns & McDonnell team.

## 1.2 CONCLUSIONS

Weston did not fully consider the severity of the potential consequences associated with basal heave and other failure mechanisms during its comparative analysis; as a result, the subsequent recommendation of near shore dry excavation as part of the preferred remedy results in risks not considered in the ROD. This report sets forth numerous unacceptable consequences of near shore dry excavation that, in our opinion, indicates this remedy is a poor choice for the Site compared to available alternatives, including the following:

1) The hybrid remedy required by the ROD cannot be performed safely; is less protective to human health and the environment than other best available technology (BAT) including wet dredge, an enhanced confined disposal facility (CDF) or alternative applications; and cannot meet nationwide industry safety standards, as designed.

2) The Weston memo significantly revises the hybrid remedy that was evaluated in the Feasibility Study (FS) and ROD. Weston's proposed modifications, which were not evaluated under the National Contingency Plan (NCP) criteria, dramatically alter the nature of the remedy and increase the remedy costs above those identified in the FS and ROD.

3) Weston's analysis of basal heave is neither complete nor comprehensive, and should not be considered sufficient basis for supporting selection of the hybrid remedy. Weston's conclusions that upward heave is not significant and that the shear strength of the Miller Creek Formation protects against basal heave, infer a degree of safety that is not warranted by the analysis completed. Weston's analysis concluded that the risk of basal heave was insignificant, based solely on an analysis of heave related to elastic rebound; however, Weston did not consider the possibility of heave due to flexure, or distortion, of the Miller Creek Formation. While some small degree of heave related to elastic rebound may occur, the amount of heave that could occur due to flexure of the Miller Creek Formation under the existing conditions along the shoreline is much more significant, and should have been considered. Furthermore, in addition to *underestimating* the potential for significant upward heave, Weston also *overestimated* the degree of protection against basal heave from the strength, or shearing resistance, of the soils[1]. Shear strength cannot resist potential failure as the exposed surface area of the excavated surface expands during construction, because the surface will behave as a rigid beam only for very small surface areas. As the linear extent of the area expands, the uniform artesian pressures acting on the base of the "beam" causes increased deflection at the center. This increased deflection results in a loss of rigidity (stiffness), causing a failure in bending of the beam (a breach in the aquitard).

[1] Shear strength is the strength of a material or component against the type of yield or failure where the material or component fails in shear. A shear load is a force that tends to produce a sliding failure on a material along a plane that is parallel to the direction of the force. In soil mechanics, shear strength is a term used to describe the magnitude of the shear stress that a soil can sustain. The shear resistance of soil is a result of friction and interlocking of particles, and possibly cementation or bonding at particle contacts. Due to interlocking, particulate material may expand or contract in volume as it is subject to shear strains.

The maximum linear extent allowable before failing in this mode is an unknown variable at this time. However, it is apparent that under existing conditions, dry excavation near the shoreline cannot be performed to meet industry standard criteria or safety objectives, and the required dewatering activities risk remobilization of a non-aqueous phase liquid (NAPL) and dissolved plume in groundwater, if basal heave (or other failure mechanisms) were to occur.

4) Basal heave is not the only failure mechanism that the ROD's comparative analysis did not adequately evaluate. Numerous modes of remedy failure are likely (basal heave; piping; containment wall failure; increased emissions; lakeside containment failure or overtopping; dewatering management/failure and associated water volume, and discharge and mobilization of NAPL and dissolved phase plumes in the Copper Falls Aquifer to Lake Superior).

5) Data gaps and uncertainties associated with the applicable failure mechanisms demonstrate why industry standards, including those that have been adopted and incorporated into building codes for safety, must be purposefully met and approached very cautiously and carefully. The risk of loss of human life, injury and permanent harm to the environment associated with ignoring this need clearly show that compromise on these issues is not permissible. Even if additional data is collected, a high degree of uncertainty will remain, and NSPW will not accept a reduction in factor of safety that does not meet the bare minimum industry standard.

6) The effects of remedy failure mechanisms are especially destructive and beyond repair (for example, the safety of workers in the dry dredge area; the extreme effort required to adequately repair the aquitard if breached, and the environmental damage from the resultant NAPL and plume migrations). As a result, the hybrid remedy fails to meet the protectiveness standards established in the National Contingency Plan (NCP).

7) The hybrid remedy attempts to achieve a perceived reduction in toxicity or mobility of NAPL and dissolved plumes at great costs and otherwise avoidable long- and short-term risks. At the same time, Weston's view of the hybrid remedy creates new implementation challenges never conceived or studied during the FS or the ROD (e.g. containment cells created with sheet pile walls perpendicular to the shore line that will limit operations within such cells). The hybrid remedy also does not consider appropriate and associated costs; and minimizes issues related to

community acceptance (e.g. extended duration of public facilities closures, odor/nuisance issues, etc.) associated with the dry dredge generally, and Weston's method in particular.

8) A wet dredge or other alternatives to the proposed hybrid remedy, such as an enhanced CDF, can and have been achieved with success as measured by the percent removal/sequestration of contaminated sediments using BAT. These measures will simultaneously avoid the related technical, safety, and other failure mechanism risks associated with the proposed dry excavation approach, significantly reducing cost.

## 1.3 ORGANIZATION

This report is organized as follows:

- Section 1 introduces the purpose and summarizes main conclusions of the report.
- Section 2 presents a general discussion on the development of factors of safety and precedent.
- Section 3 provides a technical review of the referenced Weston memo and presents areas of Weston's analysis that are incomplete and identifies factors not considered at all in the evaluation.
- Section 4 supplements Section 2 by providing a description of work commissioned by NSPW to understand the technical aspects of additional Site-specific failure mechanisms that were not fully understood or studied by EPA at the time the ROD was published.
- Section 5 examines the comparative analysis, presented in the ROD that was used to select near shore dry excavation as part of the Preferred Remedy, and discusses how the information provided herein impacts the outcome of the same.
- Section 6 summarizes an assessment of the reference sites listed in the ROD and additional sites, and demonstrates that dry excavation is not appropriate for the Site, based on available precedent and peer experience. More specific details regarding each Site are included in Appendix C.

This report has the following appendices:

- Appendix A summarizes the historical facts regarding how the dry excavation came to be proposed by EPA and supported, in part, by the Weston memo.
- Appendix B provides a summary of the firms and personal qualifications of the Burns & McDonnell team.
- Appendix C presents supporting details for the precedent and example sites discussed in Section 6 of the report.

- Appendix D presents a tabulated summary of numerous sediment remediation projects researched for comparison and precedent associated with features such as wet dredge, dry excavation, CDFs and enhancements, etc.

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# 2.0 FACTOR OF SAFETY

The factor of safety (or safety factor) is a term that describes the capacity of a load bearing system compared to the loading or pressure placed on the system. If a system has a capacity to carry a certain load, and the load placed applied to the system is greater than the capacity, then the factor of safety would be less than 1.0. If the system capacity and applied load are equal, the factor of safety would be exactly 1.0, and if the load applied to the system is less than the system capacity, the factor of safety would be greater than one. Factors of safety are developed to account for unknowns and circumstances that cannot always be predicted with pinpoint accuracy, such as, for example, variations in materials, dynamic conditions, unexpected loads, misuse, and degradation.

In the engineering field, the term factor of safety can mean different things, such as an absolute Factor of Safety, similar to what is described above, or factors of safety imposed by law, standard, precedent, specification, or custom to which a system must conform. Promulgated factors of safety have been developed to account for variables and uncertainties that are considered the bare minimum, otherwise the design is inadequate. Therefore, if a promulgated factor of safety is 2.0, then the system must be designed to withstand twice the anticipated load.

Factors of safety that apply to soil mechanics and foundation engineering, including the design of sheet pile walls, are published in many reference textbooks and in some cases have been incorporated into building codes and guidance documents. In many instances, acceptable factors of safety are presented as ranges that consider factors such as variability in soil conditions, temporary versus permanent construction, temporary versus permanent loading, and climate in the location of construction (e.g. potential for snow, earthquakes, hurricanes, etc.). The selection of a factor of safety from a suggested range requires engineering judgment as part of the design process.

The dry dredge will require the installation of a sheet pile retaining system that must resist the uneven lateral forces caused by dewatering the lake inside of the wall, and excavating the sediments. In addition, the design of the retaining system must account for potential variation in the underlying Miller Creek Formation materials and properties, uplift forces associated with the Copper Falls Aquifer, and loads generated by waves, wind and ice. Because construction workers and equipment will operate inside the dewatered area, any failure of the sheet pile retaining system would be life-threatening; accordingly, any design would need to comply with recommended precedents and relevant factors of safety. In addition to endangering construction workers, additional consequences including massive flooding in the area, property damage to the residential population and the nearby church and school is likely, as well as mobilization of the otherwise stable NAPL plume in the Copper Falls Aquifer are.

Research regarding factors of safety was conducted to determine the most relevant guidelines for the project circumstances. The Unites States Army Corp of Engineers (USACOE) publishes criteria that are used by many design engineers and have been adopted by many building codes throughout the country. Factors of safety are specified dependent on the mode of failure being considered. Factors of safety that pertain to bearing capacity are different than those that pertain to overturning or heave. The primary failure modes that must be considered in the dry dredge scenario are heave and overturning. Overturning applies to the retention structure. Factors of safety from applicable industry standards that pertain to heave vary between 1.25 and 2.0 (as discussed in Section 3.0), depending upon specific site conditions. The literature regarding applicable factors of safety is discussed in more detail in Section 3.3 of this report.

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# 3.0 BASAL HEAVE FAILURE MECHANISM

The Weston memo addresses four geotechnical issues related to the proposed removal of five feet of sediment from a specific area of the lake bottom. As considered by Weston, the proposed excavation would be made in the dry, which would involve driving sheet piling around the perimeter of the area to be excavated, dewatering the interior and then removing sediment in the dry by standard excavation methods. The four geotechnical issues considered by Weston were sheet pile design, upheaval of the excavation bottom surface, excavation bottom stability, and an evaluation of seepage gradients.

The primary issue addressed in this section is the phenomenon of basal heave. Basal heave is the upheaval, and possible rupturing, of the Miller Creek Formation in response to the unbalanced artesian pressure from the Copper Falls Aquifer underlying the formation that will result from the removal of water and several feet of material during the dry excavation program. Such a condition could lead to major loss of life and severe environmental damage, as breach of the aquitard could result in flooding of the dry dredge area while workers are present in the work zone and/or mobilization of the presently-contained groundwater plume underneath the Site. The following discussion evaluates Weston's analysis of this condition, and presents the Burns& McDonnell Team's associated critique.

## 3.1 WESTON PREMATURELY CONCLUDES UPWARD HEAVE IS NOT SIGNIFICANT

Weston has concluded the following regarding basal heave:

- Heave is a function of the natural rebound of the material below the excavation (as stress is relieved, elastic materials expand, or rebound);
- The amount of upward heave is not significant; and
- The shear resistance of the Miller Creek Formation is sufficient to prevent mass upward movement of the exposed dry excavation area (with certain area limitations).

Weston also concluded that collection of additional geotechnical data regarding the Miller Creek Formation material properties and characteristics is required. EPA indicated that this issue would be reassessed when this data becomes available.

The Burns & McDonnell team concludes the following:

- The upward heave can be attributed to flexure of the aquitard layer in addition to elastic rebound;
- The amount of upward heave may be significant and should be evaluated;
- Without specifying areal extent it may not be appropriate to consider the shearing resistance of the Miller Creek Formation when determining the factor of safety for basal heave; and,

The factor of safety in some areas of the bay may be too low to conduct the excavation
In addition, if the ROD's dry dredge program is implemented, the uplift pressure caused by the artesian conditions in the Copper Falls Formation beneath the bay will result in unsafe conditions once the base elevation (590 feet mean sea level [msl]) is reached, and could possibly cause a basal heave failure. A basal heave failure has the potential to rupture the Miller Creek Formation, which would cause a permanent short-circuit through the confining layer. This type of failure could cause significant harm and permanent damage to the environment by changing groundwater flow patterns and mobilizing the free-phase and dissolved plumes beneath the Site thereby expanding the volume of aquifer that is affected. It could also cause contaminated groundwater to start to migrate directly to Lake Superior at high flow rates in the near shore area in the bay.

## 3.2 TECHNICAL ASSESSMENT OF BASAL HEAVE FAILURE

### 3.2.1 Prior Work Related to Artesian Pressure Based Basal Heave

During a Technical Work Group Meeting held in Madison, WI on May 29, 2009, and prior to the release of the Weston memo, NSPW, Wisconsin Department of Natural Resources (WDNR) and EPA discussed the relationship between the existing artesian pressure and the potential basal heave resulting from the dewatering and material removal that would occur in a dry excavation approach. The conceptual site model used in this discussion is provided below in Figure 3-1. This work was referenced and included in the Weston memo and provided material context to Burns & McDonnell's team review of Weston's memo–which is discussed herein.

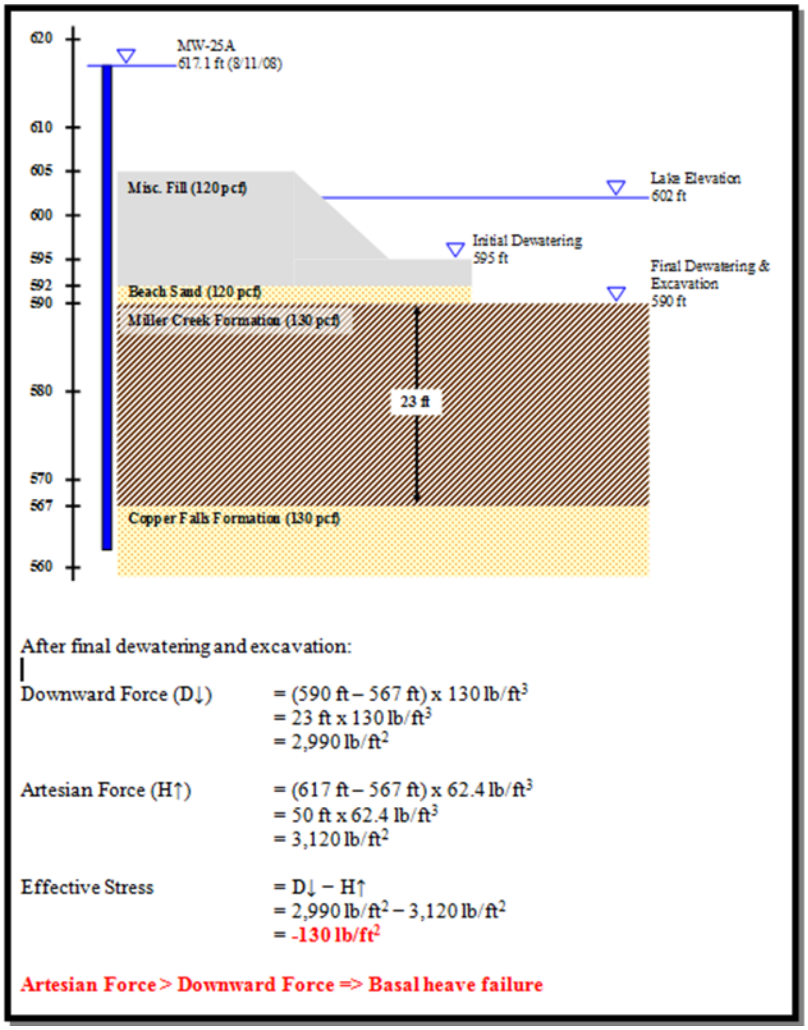


**Figure-3-1: Conceptual Site Model and Evaluation of Basal Heave Potential, as depicted in the Technical Work Group Meeting in Madison, WI on May 29, 2009**

Burns & McDonnell reviewed the above-referenced figure and a draft memorandum titled *Preliminary Geotechnical Review – Sheet Pile Wall Installation for the Ashland/NSPW Lakefront Site* prepared by Foth and Van Dyke, June 1, 2009 (the Foth and Van Dyke memo). The information and conditions provided in this draft memorandum established a potential uplift or basal heave condition where the upward pressure due to the head in the Copper Falls Aquifer (confined aquifer) exceeds the downward pressure due to the unit weight and thickness of the unexcavated materials, when evaluated at the base of Miller Creek Formation. This net uplift condition is depicted in Figure 3-1 as a negative effective stress. As shown, the excavation is assumed to occur to the top of the Miller Creek Formation materials, such that the only downward pressure is a product of the thickness and unit weight of the Miller Creek Formation. The confined head was assumed to apply at the base of the Miller Creek Formation.

Based on this evaluation there are three general factors that influence uplift: (1) the thickness of the Miller Creek Formation, (2) the head in the Copper Falls Aquifer, and (3) the unit weight (or density) of the Miller Creek Formation.

The Burns & McDonnell team reviewed the lithological data from the Remedial Investigation (RI) and groundwater elevations in groundwater monitoring wells to evaluate the potential variability within these three factors. Laboratory results were not available to assess the variability of the unit weight of the Miller Creek Formation. The monitoring wells that were evaluated are nested, and the data from the deeper screened interval (below the bottom of the Miller Creek Formation) were used. The only data available regarding the thickness of the Miller Creek Formation was obtained from soil borings and monitoring wells along the current shoreline. The proposed dry excavation is in an area of the bay where direct measurements of unit weight, thickness and head have not been completed. Due to the importance of head, weight and thickness in assessing the likelihood of basal heave, and the uncertainty surrounding each such factor at the Site, the Burns & McDonnell team's review focused on impacts associated with changes and variations in these three parameters.

Results from the Burns & McDonnell team evaluation are as follows:

- The "base" condition established by Foth and Van Dyke and presented in Figure 3-1 above provides a net uplift pressure (heave condition) of 130 pounds per square foot (psf). This net uplift condition can also be expressed in terms of a factor of safety, determined by dividing the downward pressure by the artesian pressure. In systems where all variables, material properties, and forces are known, a factor of safety value equal to or greater than one theoretically indicates a stable condition, while a factor of safety value less than one indicates imminent failure will occur before the design load is met (in the case of Ashland - a net uplift, or basal heave condition). Because of soil and other variability in natural settings, industry standards vary for acceptable minimum factor of safety values. These standards generally vary from 1.25 – 2.0 (also see Section 2.3). For the conditions depicted in the "base" Foth and Van Dyke case, a factor of safety against basal heave of 0.96 is calculated – an unsafe condition where basal heave may be imminent.
- A unit weight variation of ten pounds per cubic foot (pcf) was considered to determine the significance of variation in the unit weight of the Miller Creek Formation on the basal heave factor of safety. Using the base conditions of phreatic surface (the elevation of 617.1feet equivalent to the free surface "pressure' level of the confined Copper Falls Aquifer) and aquitard

thickness (23 feet), and varying the Miller Creek Formation unit weight between 125 pcf and 135 pcf, the basal heave factor of safety varied between 0.92 and 0.99 – a range where all values are unacceptable.

- The basal heave factor of safety varied between 0.92 and 1.35 considering the actual thicknesses of the Miller Creek Formation at three boring/monitoring well locations along the existing shoreline (thickness varied between 23 and 40 feet at groundwater monitoring wells MW-24A, -25A, and -26A), the confined head and the base unit weight of the Miller Creek Formation (130 pcf). Note that even the highest value for the factor or safety in this range is still significantly below the range of accepted industry practices as described in Section 3.3.
- The factor of safety varied less than three percent when utilizing the base unit weight, and considering the variation in phreatic surface elevation and the actual thickness of the Miller Creek Formation at the groundwater monitoring wells MW-24A, -25A and -26A locations. The factor of safety values ranged from 1.23 to 1.25 at the MW-24A location, from 0.94 to 0.97 at the MW-25A location, and from 1.33 to 1.34 at the MW-25A location. The variation of the head in the Copper Falls Aquifer is represented by five readings obtained over a four year period.
- An evaluation of these factors of safety estimates indicates that the variation in thickness of the Miller Creek Formation materials, as observed in site borings, has the most influence on the calculated basal heave factor of safety, when compared to the variation in the confined head and the variation in the unit weight of the Miller Creek Formation materials.

### 3.2.2 Amount of Heave

Weston concluded that the amount of upward heave is not significant, and that this heave is related to elastic rebound (or decompression) of the Miller Creek Formation material. While soil materials will elastically rebound when unloaded, and the Burns & McDonnell team concurs that there is a small amount of heave associated with elastic rebound, the amount of heave due to flexure, or distortion, of the Miller Creek Formation material may be significant and should be considered and evaluated. Weston did not seem to recognize the significance of the issue associated with distortion and did not address it in their analysis.

This flexure can be described as the bending or flexing of a thickness or “beam” of material as a pressure is uniformly applied to its surface. While soil materials have different properties than traditional materials than a beam would be constructed of, such as wood, concrete or steel, the material behavior is similar. This flexure or bending concept is depicted in Figure 3-2 below.

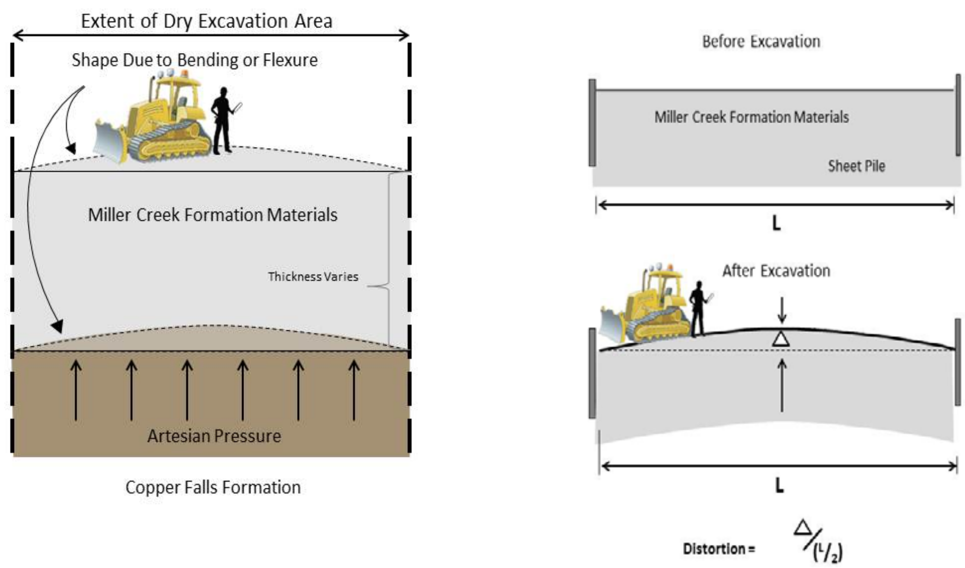


**Figure 3-2: Conceptual Bending or Flexure Model and Distortion Concept**

To understand the concept of distortion, consider a “beam” of clay material where one end is held rigid and the other end is pushed upward or deflected relative to the fixed end. The distortion is the deflection of the beam divided by one half of the length of the beam.

The situation depicted in Figure 3-2 could be considered analogous to dry excavating an area of the lake bed, where the rigid end is the edge of the excavation, the deflection occurs in the middle of the excavation area, and the upward force is generated by the artesian pressure. The distortion would be the upward deflection divided by the distance from the edge of the excavation to the middle of the excavated area.

Figure 3-3 illustrates the potential consequences of heave and cofferdam failure. Basal heave will cause water to enter a cofferdam from the base of the excavation. The rate at which the water bubbles or pipes up into the base of the cofferdam is not easy to predict, but a rapid rate could cause devastating consequences. For example, flooding of the cofferdam shown in Figure 3-3 destroyed the computer in the engine of the excavator, and the equipment was sent to salvage for spare parts. Fortunately, in this instance, the water entered the cofferdam during non-working hours, so no lives were lost.


**Figure 3-3: Potential Consequences of Basal Heave[2]**

Weston concluded that the strength (shearing resistance) of the Miller Creek Formation can be considered when determining the potential for basal heave for areas of dry excavation measuring up to 150 feet by 200 feet. Consideration of shearing resistance may not be appropriate for larger areas of excavation.

While Weston considered a number of different sized areas and the shearing resistance on the perimeter of those areas, Weston did not evaluate the maximum size area that would act as a stiff beam before upward deflection would occur due to the underlying artesian head. For instance, a block of soil one foot square in area would act as a stiff plug; therefore the shearing resistance of the perimeter could be considered in the uplift resistance. Weston did not evaluate how large an area could be while still acting as a stiff plug (that can count on the shearing resistance). At some areal extent, material can deflect as a membrane and the shearing resistance along the edges is no longer material to the basal heave resistance. Thus, at some size excavation areas, the dry excavation bottom may fail due to flexure or distortion independent of any shear strength that may be included in the factor of safety calculations.

[2] Photo illustrates 5 to 8 feet of water in a cofferdam that was previously dry

### 3.2.3 Potential Effects of Basal Heave on Groundwater Flow System

The effect of basal heave on the groundwater flow system in a failure sequence is illustrated in Figure 3-4. First, sheet pile is driven into the sediment at the edge of the excavation, both on the shore and in the water. Then the area is dewatered and material is excavated from the area inside the sheet pile wall. Flexure, and then failure, of the aquitard may begin when the clay is fractured due to basal heave. After the aquitard is ruptured, groundwater flow will start to occur along the plane of the fracture. Flow is likely to be rapid along the fracture plane because the head in the confined aquifer is 20 feet greater than the lake surface in this area. The permeability along the fracture zone will increase as water flowing along the fracture causes piping and transport of sandy material from the Copper Falls Aquifer into the fracture. Eventually, the head difference between Lake Superior and the confined aquifer will be dissipated, and groundwater discharge to the lake will be focused along the newly created conduit. This new conduit will distort the pre-existing equilibrium flow conditions, and in the new equilibrium conditions, flow in the Copper Falls Aquifer may be distorted sufficiently to remobilize the existing contaminant plume, resulting in direct discharge to Lake Superior.

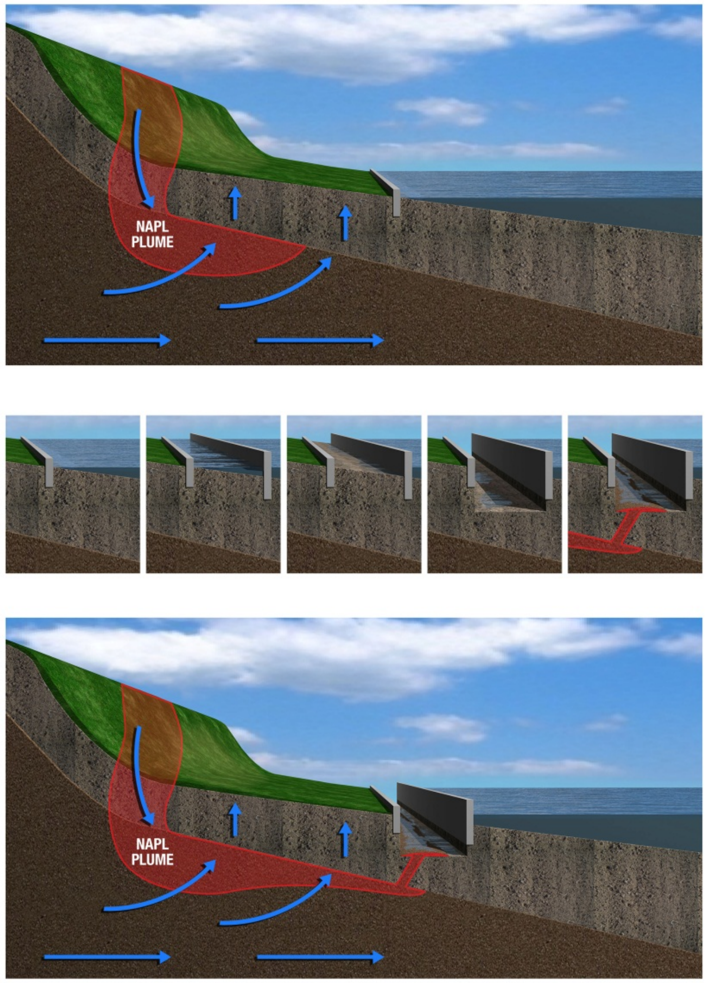


**Figure 3-4: NAPL and Plume Migration Due to Basal Heave Failure**

## 3.3 APPROPRIATE INDUSTRY STANDARDS

In the Weston memo basal heave refers to the stability of a defined thickness of the Miller Creek Formation, as determined by summing the upward forces and the downward forces acting on the formation (see Figure 3-1). The upward forces consist of the pressure exerted by the artesian head. The downward forces consist of the pressure generated by the in-place unit weight of the Miller Creek Formation multiplied by its thickness. Refer to Figure 3-1 above for a depiction of material profile and an example of the determination of the pressures. In its analyses, Weston also considered a downward force consisting of the shear resistance of the Miller Creek Formation and the associated resistance of the shearing plane defined by the area of the block.

The factor of safety is then defined as the summation of the downward forces divided by the summation of the upward forces. A factor of safety less than 1.0 indicates that the block will move upward, while a factor of safety greater than 1.0 indicates that the resisting forces exceed the upward forces, and upward movement of the block will not occur. However, these values assume perfect knowledge of all variations in natural systems, which is not realistic; accordingly, industry standards require a minimum safety factor that is greater than 1.0, as described below.

A review of published safety factors specific to heave and dewatering projects was conducted to establish a range for design factor of safety. Listed factors of safety from applicable industry standards vary between 1.25 and 2.0, depending upon specific site conditions, as follows:

**Table 3-1: Industry Standards Regarding Basal Heave Factors of Safety**

| |
|---|
| **DEWATERING AND GROUNDWATER CONTROL (1983)<br>ARMY TM 5-818-5AIR FORCE MANUAL NO. 88-5, CHAPTER 6; NAVY MANUAL NO. P-418** |
| • Factor of safety refers to design of dewatering, pressure relief and groundwater control systems<br>• Uplift Factor of Safety = 1.25 to 1.5 |
| **ARMY CORPS OF ENGINEERS<br>TECHNICAL LETTER NO. 1110-2-307 (1987)** |
| • Uplift calculations should conform to ETL 1110-2-307 “Flotation Stability Criteria for Concrete Hydraulic Structures”<br>• During Construction Factor of Safety= 1.3 (100 yr. flood, only applies to urban areas)<br>• Normal Operation Factor of Safety= 1.5 (Design Stage)<br>• Extreme Conditions Factor of Safety= 1.1 (Top of flood protection) |
| **NAVFAC, DM7-02 (1986)** |
| • Permanent Factor of Safety= 2.0<br>• Temporary Factor of Safety= 1.5 |
| **ARMY CORPS OF ENGINEERS, GUIDANCE MANUALS (UNDERSEEPAGE)** |
| • Factor of safety refers to temporary or permanent excavations.<br>• Heave Factor of Safety $\geq$ 1.5 (For design water/flood elevation)<br>• The above factors of safety references applied to permanent and temporary structures or excavations. Factors of safety ranged from 1.1 to 2.0 depending upon application. |

As described above, the factor of safety associated with the ROD remedy varies between 0.92 and 1.35 using Miller Creek Formation thicknesses inferred from the existing Site borings, varying the piezometric head, and varying the unit weight of the Miller Creek Formational material, as compared to the recommended range of 1.25 to 2.0. Note that these factors of safety do not consider the shear resistance of the Miller Creek Formation.

## 3.4 SUMMARY OF BASAL HEAVE ASSESMENT

In summary, the Weston evaluation has not considered the permissible amount of upward movement of the base of the excavation due to the underlying artesian pressure. It limited the analysis to the contribution provided by the shearing resistance of the Miller Creek Formation material along the proposed excavation perimeter in the resistance to upward forces, but only for areas no greater than 150 feet by 200 feet.

Of the variables and Site conditions considered, the thickness of the Miller Creek Formation affects the factor of safety to the greatest degree (within the ranges considered for the other factors). In addition, the conditions that have existed along the shoreline of the potential excavation area indicate factors of safety less than 1.0 against uplift or heave of the Miller Creek Formation may exist at certain locations. Considering that there is no site-specific information to evaluate these factors of safety in the area where the excavation will be completed (out in the bay), there is the potential that conditions exist in the proposed excavation area, that will result in a factor of safety against uplift less than 1.0, or sufficiently low that there will be risk of heave during the dewatering and excavation process.

Existing data suggests that the existing conditions will result in unacceptable factors of safety that increase short term risks associated with worker safety and long term risks associated with significant harm and permanent damage caused by mobilization of the existing plume.

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# 4.0 ADDITIONAL SITE-SPECIFIC FAILURE MECHANISMS

Any remediation project involving excavation, earth and water retention, and dredging presents safety and environmental issues and concerns that must be addressed. As discussed in Section 1.1, Weston's objective was broader than an evaluation of basal heave and included, as a stated objective, the evaluation of "other failure mechanisms that could pose a potential risk to workers, the environment, and to the successful completion of the project". This section enumerates additional near shore dry excavation failure mechanisms that were not discussed by Weston. The proposed remedy to address sediment clean up at the Site presents many unique safety and environmental concerns to overcome that could be mitigated if the approach was modified. Lake Superior is the largest fresh water lake in the world so the fetch resulting from the size and depth are also the largest. The fetch and depth in the bay, although reduced when compared to the larger open waters of the lake, are still nonetheless relatively long and deep at the confluence. Man-made modifications to the lake are unique and atypical of projects on other water bodies such as rivers, ponds, lagoons and other lakes or areas that are protected or sheltered from open water conditions.

The following is a discussion regarding both safety and environmental concerns that represent significant additional failure mechanisms associated with dry excavation of near shore sediments as described in EPA's preferred remedy.

## 4.1 LAKESIDE CONTAINMENT FAILURE

Any dry excavation approach requires a temporary containment structure to be built in the lake to keep water from entering the dry area via seepage, or overtopping from wave action. Because a failure of the containment system could be life-threatening for anyone inside or near the area, the system requires specialized design and construction.

The ROD contemplates that a lakeside containment wall would be constructed using steel sheet piling with an interlock sealant, to minimize seepage. Specifically, the ROD envisioned that PZ-35 steel sheeting would be driven into the underlying Miller Creek Formation approximately 20 feet. However, the Miller Creek Formation, which has been measured at 23 feet thick at MW-25A along the shoreline southwest of the former waste water treatment plant, is not thick enough to provide adequate protection against a wall breach. The ROD also ignores the need for exploratory trenching along this alignment to locate and excavate obstacles or debris that would prevent sheeting installation, and notes that a preliminary structural analysis of the PZ-35 wall system indicated that a wave attenuator or break water will be necessary to ensure a desired wall deflection of approximately six inches or less.

While the EPA's plan is conceptual and EPA notes that the final design of the lakeside containment wall will be determined during Remedial Design (RD), many Site conditions complicate a dry excavation scenario. These Site conditions must be considered and are problematic, particularly considering that the subsurface conditions are not well-suited to installation of sheeting (especially if deeper driving is required). Complications at this Site include the following:

- The lakeside containment system must be able to withstand the dynamic loads imparted by wind/wave action, and possibly even ice loading between seasons, depending on sequencing.[3]
- Pre-clearing will likely be necessary for both the landside and lakeside alignments, due to the stiffness of the Miller Creek Formation and the potential for subsurface obstructions. When sheet piling is driven in areas that have been subjected to historical development that includes subsurface filling, such as at the Site, many unseen obstructions will likely be encountered during installation of sheet piling. If obstructions are significant, they will prevent driving sheeting through the overburden. These difficulties were realized during the construction of the slip directly north of Kreher Park. When the KIYI slip was constructed, sheeting was extremely difficult to install due to the presence of the obstructions (remnants of an old wood dock in the overburden) and the stiffness of the Miller Creek Formation. This will be an issue for the eastern portion of any lakeside containment system at the Site due to the pile density in that area.
- The Miller Creek Formation is hard (blow counts [N-values]>30/ft.), and will make driving sheeting to any depth difficult. The high blow counts anticipated with the overconslidated glacial till of the Miller Creek Formation may exacerbate pile driving efforts, damage the sheets (e.g. compromise the quality of the interlocks) or even preclude driving the sheets to the depths necessary for the desired structural stability. If the interlocks cannot be completely competent, they will not be able to be sealed to prevent infiltration of water.
- Where sheets are driven to depth, preferential vertical pathways may be created that allow NAPL to migrate vertically to impact media that has been isolated from such contaminants.
- The isolation of portions of the bay by a lakeside containment system will alter the velocity of bed currents on the lakeside toe of the sheeting which will result in scour and mobilization of pre-

[3] Weston prepared a conceptual design of a sheet pile wall to retain the waters of Chequamegon Bay as part of its dry dredge analysis. As stated on page 6 of its summary "It should be noted that no external forces, such as those due to wave and ice loading, were included in the preliminary design".

existing contaminants in the sediment media. Scour is defined as the removal of the granular bed material by the hydrodynamic forces in the vicinity of the structure. See below for a further discussion of the site-specific wave study that was conducted in the bay in 2011.

The design of the containment system will have to consider the lateral forces associated with the water depth in the lake, but also other less predictable forces including waves, ice and storms. The water depth along the proposed lakeside containment wall varies but has been measured to a maximum of nine feet.

Figure 4-1 is a photo of a retention system with water on one side and an intended dry base on the other side. The retention system failed, and water from the Dubai Marina can be seen rushing into the once dry area. This is a real depiction of what a retention wall failure looks like. A massive volume of water came rushing into the dry area with no control whatsoever. Such a failure could result in loss of life, but fortunately, the 100 workers were saved.

**Figure 4-1: Photograph of Retention Wall Failure**

### 4.1.1 Site-Specific Wave Study

Evans-Hamilton, Inc. was retained to conduct a wave study from July to October of 2011 to understand the wave and current environment in the bay during non-ice periods. Coast and Harbor was retained to perform modeling activities. It was assumed that wave and current energy is inserted into the bay on an episodic, event driver basis (storms, daily winds, etc.) rather than a constant basis. Based on this assumption, in-situ measurements were used to capture conditions during these events. In addition, over-the-side instruments were used for short durations during servicing trips to supplement the in-situ data.

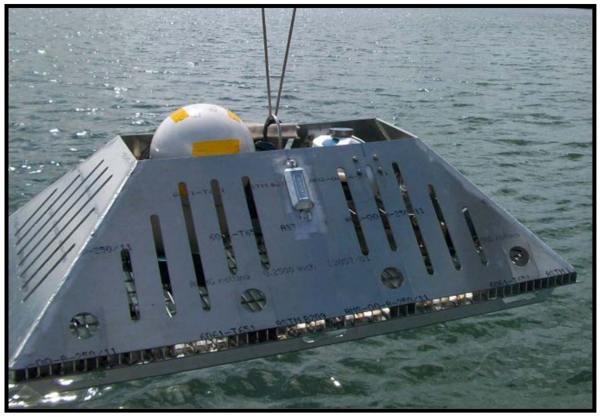

**Figure 4-2: TRBM Containing ADCP Being Deployed**

Currents were measured at 3 sites using a combination of profiling acoustic Doppler current profilers (ADCP) and single point meters. The ADCP is capable of measuring current velocity profiles (full water column) and water level at the same time. Each current profile was measured and averaged over a 2 minute period every 10 minutes. The ADCPs were mounted within a low relief trawl resistant bottom mount (TRBM) and set within a pair of gimbals to allow the transducer heads of the meter to have minimal tilt with reference to the water surface. The TRBM has sloped sides to minimize being caught or snagged by fishing nets or other debris, a base composed of grating so as to minimize suction forming under the mount, and slotted sides to minimize sediment or sand accumulation. In addition to the ADCP, the TRBM also contains a buoy/release system for recovery without divers.

The wave data and wind data recorded from the area was applied with consideration of the fetch and depth of water. These Site conditions were evaluated and modeled to estimate lateral wave forces that must be reasonably expected in the design of any lakeside containment structure intended to hold back the lake water from entering the area to be excavated in the dry. Wave modeling was conducted on one large (120 meter x 120 meter cells) and two fine (30 meter x 3 meter, and 1.5 meter x 1.5 meter) modeling grids to propagate wind-waves from deep water to the Site. These are shown side-by-side below for reference purposes.

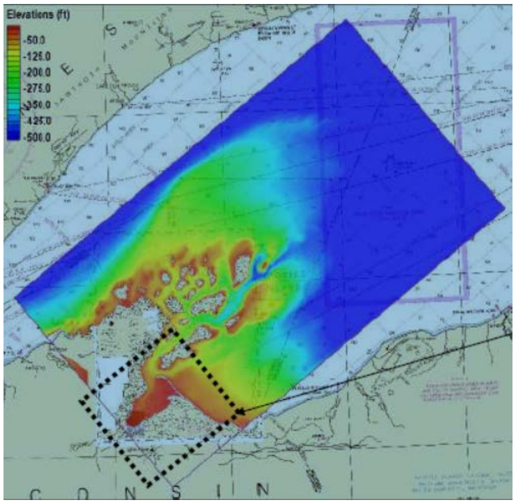


**Figure 4-3: Large Scale Grid, 120 x 120 m**

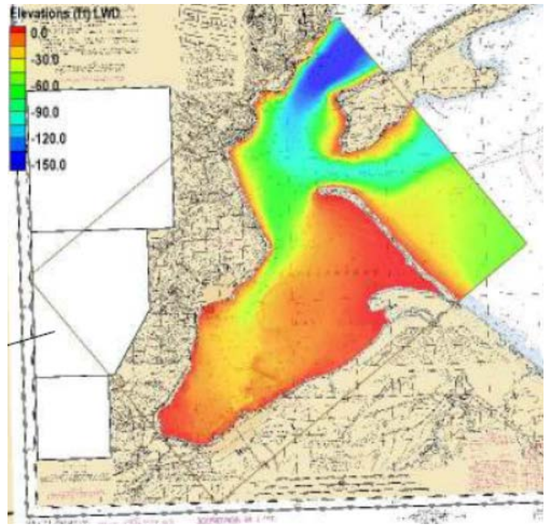


**Figure 4-4: First Nested Grid, 30 x 30 m**

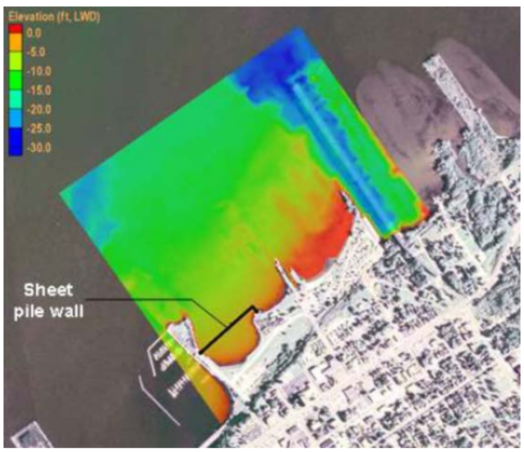


**Figure 4-5: Second Nested Grid, 1.5 x 1.5 m**

**Figure 4-6: Wave Study Data Extraction Points**

The wave modeling results indicate wave heights associated with a 50-year return period storm reaching a maximum height of 5 feet in Chequamegon Bay and less than 3 feet at the Site. Because it is not practical to construct a lakeside containment system that meets all required safety and environmental needs, conduct the required dry excavation, and remove the containment system all in one construction season, the wave study data was applied to a hypothetical lakeside containment alignment enclosing a portion of the Site, of a size that could be completed in a single construction season.

The Evans-Hamilton/Coast and Harbor wave model indicated that the design wave heights based on a 50-year return period storm at the extraction points along the selected lakeside containment alignment varied from approximately 1.7 to 2.5 feet.

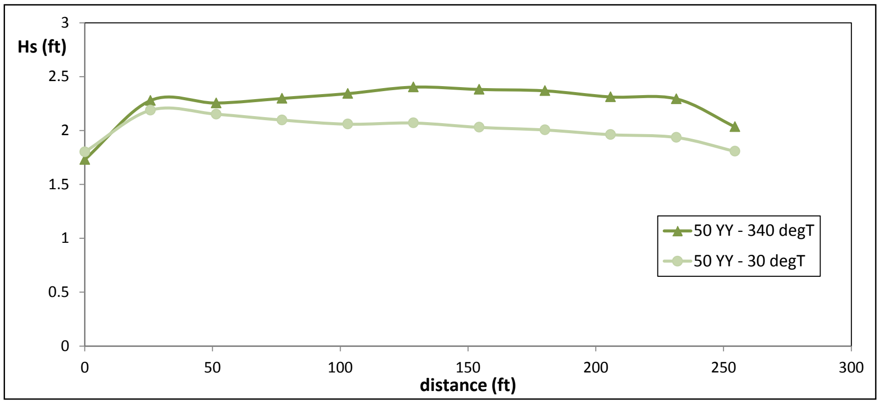


**Figure 4-7: Wave Heights at Extraction Points**

Using model output from these extraction points, Coast and Harbor evaluated the wave dynamic pressure distributions created by incident waves and the hydrostatic pressure distribution against the conceptual lakeside containment wall.

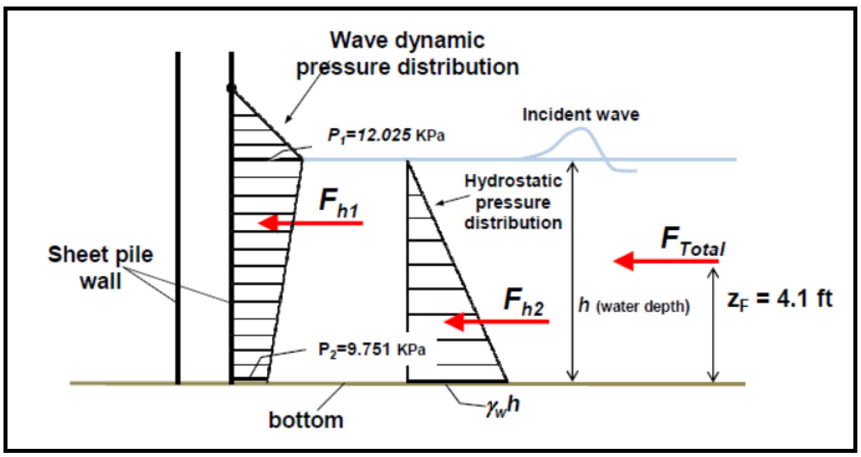


**Figure 4-8: Typical Wave Forces Cross Section**

The model prepared was then used to calculate the total wave forces on any lakeside alignment in the future. For the above reference alignment, the results indicate a hydrodynamic force ($F_{h1}$) of 2,326 pounds per foot and a hydrostatic force ($F_{h2}$) of 1,379 pounds per foot for a total wave force ($F_{Total}$) of 3,706 pounds per foot. This data can be used to design the physical dimensions and orientation of the sheeting required to withstand the anticipated forces. Also, the depth of embedment and the required strength of the sheeting (section modulus) can be specified. The above results are preliminary and will vary depending on the location of the final lakeside containment alignment, but must be considered as they are a critical force that could result in a rotation failure for any improperly designed or theorized lakeside containment system.

The hydrodynamic forces, along with other data and characteristics from the Site can be used to estimate the scour depth. In addition, the potential redistribution of the contaminated scour material into areas further out into the open waters of the bay that are not currently within the areal extent of contamination will have to be estimated using predictive modeling. The proposed line of sheeting lies within the extent of sediment contamination, so the scour will thrust contaminated sediment into areas that may be beyond the current extent of contamination. Therefore, the scope of the wet dredge portion of the project will be expanded.

Significant loading from ice will also contribute to rotational failures and damage for any containment system left in place over the winter season. Ice breaks up into large pieces that move and thrust up against the structure. The angle of contact, the velocity and the mass of the ice will vary and can be very unpredictable, but must be considered in a design. A single sheet pile wall like that described in the ROD will most likely not survive these ice loads without experiencing unacceptable deflection resulting in an unsafe structure that would have to be removed and replaced prior to the start of the subsequent construction season.

Any lakeside containment system must be designed to a reasonable factor of safety in accordance with acceptable industry standards. The design of a containment system does not conform to factors of safety in the same manner as the prior discussion regarding basal heave. In the case of containment systems, the factors of safety are used internal to the design that is essentially performance based. Typical factors of safety for retaining systems would consider sliding, bearing capacity and general stability. These typical factors of safety would have values of 1.5 for sliding, 2.0 to 3.0 for bearing capacity, and at least 1.5 for general stability. While there is no specific factor of safety associated with overturning, overturning of any retaining system should be checked. (Reference: USCOE, EM 1110-2-2502, *Retaining and Flood Walls*.) Depending upon the type of containment system, not all of these considerations are appropriate. For instance, a single sheet pile wall is not generally evaluated for sliding or bearing capacity, but it is evaluated for overall performance (deflection) and structural capability of withstanding the imparted loads.

### 4.1.2 Case Study of a Cantilever System

The FS and the ROD indicate that a single cantilever sheet pile wall may be suitable for installation to create the area to be dewatered and excavated rather than a braced wall or a cofferdam. Cantilever walls must be driven much deeper into the subsurface than the length that they are exposed to lateral forces. So a wall that must extend 12 feet above grade must be driven at least 24 feet into the ground (36-foot long sheets). A deep drive into the Miller Creek Formation could penetrate the clay, thus allowing the NAPL impacted sediment to be carried downward, closer to, or into the Copper Falls aquifer. Also, sheeting cannot be driven very deep, or even to a shallow depth if the embedment material is very stiff and resistant. The Miller Creek Formation is indeed very stiff, based on the information obtained thus far. Attempting to drive the sheets may prove extremely difficult, and the sheets may be severely damaged. If the sheets are damaged, it will be more difficult or impossible to properly align the sheets or seal the interlocks, which is required to prevent contamination from migrating through the wall. The following case study illustrates some of the difficulties associated with utilizing a cantilever wall along a waterway underlain by stiff clay.

Existing precedent suggests a cantilevered wall would not be feasible at the Site. A manufactured gas plant (MGP) site in Illinois involved installation of a sheet pile wall along the shore of the Chicago River to facilitate removal of impacted soil directly adjacent to the River to depths greater than the depth of the River. A cantilever wall was specified, and upon completion of the excavation and during backfilling, the sheet pile wall was planned to be converted into a permanent dock wall, anchored to a reaction wall using tie rods. Prior to installation of the wall, many obstructions were encountered in the overburden, and the sheeting line had to be pre-trenched to the depth of stiff clay. Installation of the wall proved to be very difficult because the underlying clay was very stiff. Several different hammers and vibratory devices were used to facilitate advancing the sheets to the design depths, but the sheets could not be driven in a vertical line, and interlocks were also compromised. Several sheets were damaged and had to be extracted and replaced. The toe of the sheets was not in line with the top of the sheets, and the wall was not straight. Additional efforts were required to straighten out the wall, although the interlocks were compromised. Since this project did not require watertight connections, it was not as significant of an issue as it would be at the Ashland Site, where damage to the interlocks could lead to serious safety risks to personnel working in the dewatered area if seepage into the area occurs. Also, unsealed interlocks could result in tar migration from the landward side of the sheeting, defeating the purpose of the containment.


**Figure 4-9: Damaged Interlock (Plan View)**


**Figure 4-10: Interlock Separation (Side View)**


**Figure 4-11: Tilted Wall Before Repair (Side View)**


**Figure 4-12: Wall Alignment After Repair**

## 4.2 DEWATERING FAILURE

An intensive dewatering system will be required to maintain a “dry” excavation. The quotation marks around “dry” are added because it is not anticipated that the “dry” excavation at this Site will be completed in a truly dry environment. US Army Corps of Engineers’ Engineering Research and Development Center’s Environmental Laboratory (ERDC/EL) have published technical guidelines (ERDC/EL TR-08-29) that describe the industry standard for completing dry excavations similar to the one proposed as utilizing conventional excavation equipment operating within dewatered containments, such as a sheet pile enclosure or cofferdams. The saturated clay and silt material characteristic of the excavation bottom and the need for foaming and or water blankets to suppress emissions of carcinogenic contaminants will result in a wet excavation – although the water column will be on the order of inches rather than feet.

Dewatering the near shore area complicates the design of the system and introduces additional safety concerns to workers and the surrounding community. The dewatering system must be designed not only to remove the water inside the containment, but also to mitigate and reduce the uplift forces resulting from the artesian conditions from the Copper Falls Aquifer.

As discussed previously, any lakeside containment system must be constructed to provide protection for worker safety; additionally, it must minimize potential flow beneath that structure (e.g. the sheet pile wall system defined in the ROD). This flow results from the differential pressure conditions between the lowered head within the containment and the lake surface following dewatering. This seepage could be further exacerbated in the event the sheets are not uniformly embedded into the aquitard. Consequently the dewatered area would be subject to potentially non-uniform, localized high seepage across the cut surface. Although the Weston memo indicated that heave of the dewatered surface from these differential pressure conditions would not be significant, it is erroneous to assume that variable soils within the upper several feet of the Miller Creek Formation are not present. These soil conditions will require constant monitoring during all dry excavation operations. Despite these efforts, pavements and other permanent marina or shoreline structures could shift or move, sinkholes could develop and flooding within the dewatered area could occur.

Besides the potential hazards from differential flow between the lake level and the dewatered containment, artesian uplift following dewatering is a real danger. The available geotechnical data for the Miller Creek Formation confining unit were previously discussed in Section 2.0. Weston's assumptions using this minimal data did not address dangerously low factors of safety against uplift at identified points along the shoreline where the thickness of the aquitard has been documented. The dewatered containment will result in removal of 12 to 14 feet of dead load from a combination of lake volume, wood debris, sandy lake bottom/silty sediments and the overcut portion of the aquitard required to meet the ROD's Performance Standards. If a massive failure or "blowout" occurs, this could lead to failure of the remedy and/or worse, personnel fatalities.

## 4.3 NAPL AND DISSOLVED PLUME MIGRATION

The discussion above focused on the many safety concerns associated with the construction work force and the surrounding community. In addition to safety problems, implementation of a dry excavation poses many concerns to the environment. There are three potential NAPL migration preferential flow pathways created by the selected remedy identified in the ROD. Firstly, by installing and extracting sheeting required for the ROD's containment system, preferential pathways could be created that have the potential to promote NAPL migration. Secondly, it is possible that waves overtopping the containment structure and precipitation events could cause migration of NAPL within the "dry" excavation by further disturbing and redistributing the sediments. Thirdly as described above, implementing a dry excavation could cause a breach in the aquitard. The rapid changes caused by this condition could mobilize the dissolved phase and NAPL plumes within the Aquifer. Data developed during the RI confirm these plumes are currently stable and are not a threat to human health and the environment. However, these data also show that the highest levels of volatile organic compounds (VOCs) at the Ashland Site have been measured within the NAPL plume. A massive blowout could result in long term detrimental impact to receptors not currently at risk. Although there is no current risk of exposure to the NAPL plume within Copper Falls Aquifer, the rapid migration of these contaminants to the near surface resulting from a breach in the aquitard would be a tragic environmental disaster. A disaster of this magnitude is unprecedented, as would be the financial and sequential cost to repair such loss and damage.

## 4.4 INCREASED RISK OF BENZENE AND NAPHTHALENE EXPOSURE

A dry excavation approach will open a large area of the bay allowing both benzene and naphthalene (two site-specific constituents of concern (COCs) to volatilize to varying degrees and result in vapor emissions. Even if a water blanket and/or foaming is used for vapor suppression, each of these compromise the dryness of the excavation bottom and make movement in the area more difficult, requiring mats and/or special equipment to maneuver within the soft wet bottom. In addition, the dry excavation method produces more interaction between three media phases (air, water and sediment) that will result in further increased emissions from exposed wet sediment surfaces as compared to submerged sediment surfaces shown by the literature (Thibodaux 1989; USEPA 1996; USACE 2003).

### 4.4.1 Evidence Supports Dry Excavation Increased Emissions

Contaminated sediments excavated from the bed of a temporary dewatered water body provide the opportunity for high release of VOC's and some semi-volatile organic compounds (SVOCs), including polynuclear aromatic hydrocarbons (PAHs) through volatilization. Theoretical models have been developed to describe the physical and chemical processes involved in transferring the VOC/SVOC from the solid or liquid phase to the air.

Volatilization is complicated and can involve a number of transfer pathways. Quantification of the volatilization of contaminants to the air is accomplished by models that have evolved from the use of laboratory and field verification of critical transfer coefficients. The models can be used to estimate the relative significance of contaminant mass flux for different sediment dredging and sediment excavation options.

With respect to dredging versus excavation of dewatered sediment, the VOC's can enter the air when two distinct conditions occur. The first condition is when the material dredged from the bed in an open bucket breaks the water surface and starts to dewater. The second is where dewatered bed sediment is excavated by dredge or land based equipment (crane, front end loader, etc.). The first condition is a dredging operation that maintains a level of wet sediment, and minimum loss by volatilization. The second condition has been labeled "dry dredge" where excavated material experiences significantly greater air exposure and subsequently greater volatilization.

### 4.4.2 Implications of Increased Emissions at Ashland

As a result of the phenomenon described above, the proposed dry excavation approach actually increases exposure risks to construction workers, requires upgrades in personal protective equipment (PPE) that may restrict individual working hours, increases costs and extends the project duration. This causes increased time duration for the loss of public facilities and risk of increased exposure duration for the surrounding community. The increased exposure risks associated with dry excavation are not limited to on-site workers as off-site receptors may also be exposed.

The proposed dry excavation approach would require an intensive ambient air monitoring program that measures emissions at the fence line and disruptive intrusions via operational controls that will slow work, delay use of public facilities and increase costs. At some sites, these types of concerns have been mitigated by performing the work in the winter; however, in Ashland two feet or more of winter ice form in the bay making this approach impractical. Emissions may be severe enough that both operational and physical controls may be necessary, further reducing the constructability of the remedy.

A dry excavation approach at this Site is not practical in the winter due to the extreme weather conditions in this area. Temporary structures and/or wind changing or blocking devices are not feasible since the remediation is in an open water environment. Managing contaminant emissions associated with a dry excavation will be extremely difficult. It is reasonable to assume that anticipated increased emissions associated with this approach will require slowing down or even shutting down the project on some periodic basis to meet contaminant emission limits that are protective of the nearby population – thus extending the schedule and risk of increasing exposure duration and the costs.

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# 5.0 CONSIDERATION OF BASAL HEAVE AND OTHER FAILURE MECHANISMS CHANGE EPA'S COMPARATIVE ANALYSIS

As required under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the NCP, and as part of the RI/FS process, EPA conducted a detailed evaluation of remedial alternatives using nine criteria and then completed a comparative analysis focusing on the relative performance of each remedial alternative against those criteria. The nine criteria are separated into three types: threshold, balancing, and modifying. Typically, threshold criteria set a minimum bar or the minimum standards that must be achieved and include: (1) protectiveness and (2) compliance with applicable relevant and appropriate requirements (ARARs), with the most important of these being overall protection of human health and environment). Five balancing criteria compare alternatives. A high rating for one criterion may compensate for a low rating for another of the balancing criteria. These are (1) long-term effectiveness and permanence, (2) reduction of toxicity, mobility, or volume through treatment, (3) short-term effectiveness, (4) implementability and (5) cost. The two modifying criteria assessed are (1) state regulatory acceptance and (2) community acceptance.

The failure mechanisms discussed previously in this report were not as extensively evaluated and as well understood during the ROD preparation phase as they are now understood in part because the Weston memo analyses were not provided to the public or potentially responsible parties (PRPs) until after the ROD was issued. If the additional knowledge had been available to EPA during ROD preparation, and particularly during the comparative analysis of alternatives, the dry excavation should have been removed from consideration based on deficiencies associated with the following:

- Overall protection to human health and the environment;
- Reduction in toxicity, mobility, or volume through treatment;
- Short-term effectiveness;
- Implementability;
- Cost; and
- Community acceptance.

## 5.1 DRY EXCAVATION DOES NOT MEET OVERALL PROTECTIVENESS GOAL

In Section 10 of the ROD, EPA indicates that dry excavation of the near shore area is more protective due to the presence of large amounts of wood waste and free product in the near shore area that could be released during into the water column dredging operations thereby exposing humans or ecological receptors to COCs. To the contrary, human receptors, including the construction workers and the surrounding community will not be protected in a dry dredge scenario. The following issues pertaining to protectiveness associated with a dry dredge were not mentioned in the ROD:

1. Significant emissions will be released once the water is removed from the contaminated sediment. Also the dry dredge requires a longer time to implement, so the potential exposure duration increases.

2. Mobilization of the plume in the Copper Falls Aquifer would create exposure pathways that do not currently exist, or otherwise exacerbate the current state of the Site.

3. Long-term permanent damage could result if the confining layer were to be short-circuited due to basal heave or through excessive depths of sheet piling. The plume has the potential to migrate toward the lake and cause significant harm to Lake Superior.

Treatment, engineering controls, and/or institutional controls can be implemented to control exposure using wet dredge, an enhanced CDF, or other remedies thereby ensuring reliable protection of human health and the environment over time. Based on the above, the dry dredge should not have been retained as a viable alternative since it fails to meet the threshold criteria.

## 5.2 DRY EXCAVATION DOES NOT REDUCE TOXICITY, MOBILITY OF NAPL AND DISSOLVED PLUMES AND VOLUME WITHOUT INCREASED RISKS

This criterion addresses the statutory preference for remedies that employ treatment to significantly reduce the toxicity, mobility, or volume of the hazardous substances. That preference is satisfied when treatment is used to reduce the principal threats at a site by destroying toxic chemicals or reducing the total mass or total volume of affected media.

EPA states that sediment residuals are generated during removal via dredging of near shore sediments along with free product co-located with wood waste. EPA asserts dry excavation is more adept at reducing toxicity, mobility and volume of contaminated sediments during removal and transport because the water column in which removal would otherwise occur is eliminated. EPA believes dry excavation is the most efficient mass removal technique due to elimination of residuals management issues; however, this is not the case as wet residuals management will be a component for a dry excavation as follows:

- The excavation will not be completely dry due to seepage, boils and quick sediment;
- A water blanket or frequent wet foaming will be needed to suppress high benzene and other volatile emissions from the working surface of the Site;
- Suspended residuals will be entrained in the shallow water blanket just like a water column, perhaps to a greater degree;
- Redistribution of suspended residuals will occur during precipitation events that disturb water blankets in areas where work has not been completed and isolated at the time of the rain event;
- The duration of the project will be increased with a dry dredge, so all of the issues above will slow down completion, or will need to be addressed for a longer period of time; and
- A significant dewatering effort will be required, which will result in the need to collect, treat and dispose of wastewater. The treatment requirements may be extensive since the water is impacted with NAPL, and other constituents that may need to be treated to very low levels prior to discharge.

## 5.3 DRY EXCAVATION HINDERS SHORT-TERM EFFECTIVENESS

Short-term effectiveness examines the short-term impacts associated with implementing the alternative. Implementation may affect workers, the neighboring community, or the surrounding environment. Short-term effectiveness also includes potential threats to human health and environment associated with excavation, treatment and transportation of hazardous substances, potential cross-media impacts of the remedy, and the time required to achieve protection of human health and the environment.

In the ROD EPA indicates that dry excavation is the best method to quickly remove COCs and achieve protection; however, EPA notes that there are increased concerns with worker safety in a dry excavation scenario. EPA concludes that dry excavation is a commonly used technology and there are effective and reliable mitigation measures, but defers the details to the remedial design phase. As shown on Table 8-11 in the FS, Evaluation of Short Term Effectiveness for Potential Remedial Alternatives for Sediment, there is no mention that SED-6 will take longer to complete than SED-4. EPA asserted that both SED-6 and SED-4 should have similar short-term risks to the public and worker health and safety during implementation; however, this is not the case as SED-6 will take longer to implement than SED-4 contrary to EPA’s assertion otherwise.

The dry excavation was only conceptualized during the FS, so it was difficult to estimate construction duration. At this time, it must be recognized that it will be extremely difficult to design a safe lakeside containment structure that meets industry standards for factors of safety described previously in this report. The short term risks associated with worker safety in the proposed dry excavation scenario are significant. In addition, until further data collection and design work is conducted, estimating the duration of the project is very difficult. The construction schedule for a dry excavation approach will be materially longer than other alternatives. Based on subsequent preliminary engineering design work by the Burns & McDonnell team on behalf of NSPW, it appears that a dry excavation approach will take two construction seasons as opposed to one construction season using the wet excavation approach due to deficiencies in the planned lakeside containment structure and sequencing issues described previously in this report. All short-term risks associated with exposure to workers and the surrounding community are extended accordingly as are the lengths of time which public facilities must be removed from service.

EPA asserted without evidence that air emissions from SED-6 exceed emissions for SED-4 because SED-6 was never evaluated in the bench-scale emission test (Appendix B2 for the FS). Review of the bench-scale emission test results, which are based on worst case scenario assumptions, tend towards a conclusion that the two alternatives would likely result in the same amount of emissions; however, nothing definitive can be stated because SED-6 was not evaluated by NSPW for air emissions.[4] It is not possible for an area covered with water to emit in the way that an open excavation emits COCs. Rather, the process implemented to handle and manage the wet (or dry) material will be a source of the emissions. If dry excavation were attempted, the resulting three phase system (air-water-sediment) would result in maximum emissions from the open cuts repeatedly exposed to air during operations. The fact that an exposed wet sediment surface has the highest volatilization rates is well-documented in literature (Thibodaux 1989; USEPA 1996; USACE 2003).

## 5.4 DRY EXCAVATION CREATES AVOIDABLE IMPLEMENTATION CHALLENGES

Implementability considerations include technical and administrative feasibility of the alternatives, as well as the availability of goods and services (including treatment, storage or disposal capacity) associated with the alternative. Implementability considerations often affect the timing of remedial

[4] Bench scale tests were completed before the Agency added SED-6 to the third draft of the FS Report

actions (for example, limitations on the season in which the remedy can be implemented, the number and complexity of material handling steps, and the need to secure technical services).

The ROD indicates that a dry excavation is an efficient and effective way to remove the significant amount of wood waste and free product since work is not taking place in the "wet" (i.e.. in water) making it possible to see what is being removed without the need to control for the release of free product to the water column. The ROD asserts that a wet dredge remedy would cause recontamination of sediment and volatilization of surface sheens and releases to the outer bay. Dry excavation reduces the potential for resuspension of residuals and contamination of off-site areas by “eliminating” work in a water column. Although specialized equipment is eliminated in a dry excavation scenario, specialized construction must be completed as part of the Site preparation work (cofferdam, sheeting, dewatering, etc.) and these activities result in safety and environmental concerns described previously in this report. The base of the dry excavation would be very soft and tend to pond water from below and from precipitation. Therefore, low ground pressure equipment; use of non-standard approaches for matting or windrowing for access, etc. may be required. This is specialized construction that has enormous impacts on schedule and costs.

EPA assumes a dry condition and possible visual observation to verify removal will make dry excavation more efficient at mass removal except a water blanket will be needed for vapor suppression. This thin water blanket will actually result in a three phase environment that will result in more sheen than less sheen, and preclude direct visual observations as described in the ROD. Because of the water blanket, residuals are still an issue and must be managed. Dry excavation will NOT provide unrestricted and complete visual observation of the excavation floor. The excavation will require wet sediment removal with occasional surface water ponding at and adjacent to the point of excavation. Visual confirmation of tarry sediment for cleanup purposes is not applicable when the threshold for cleanup is as low as 10 mg/kg and the threshold for identifying tar in sediment visually approaches 100 mg/kg (optimally) to 500 mg/kg (practically).

## 5.5 CONCLUSIONS REGARDING COST

The Weston memo materially changed the near shore dry excavation component of the hybrid remedy as envisioned in the FS and ROD by suggesting “it would be possible to install an in-water sheet pile wall approximately 200 feet from the shoreline as presently conceptualized ***as long as sheet pile walls perpendicular to this wall separated by no more than 150 feet were also installed to subdivide the dry excavation footprint into 150 feet by 200 feet cells before dewatering of any given cell*** to complete the dry excavation is permitted” [emphasis added]. EPA did not consider any of the cost or schedule impacts this modification would create in the costs presented in the FS and reiterated in the ROD. Construction of small cells described in the Weston memo will result in a substantial increase in cost and duration. There will be further productivity loss due to space limitations. Because of the construction season in the Ashland area, construction would extend to two seasons. This will further exacerbate the loss of public facilities that are taken out of service during construction.

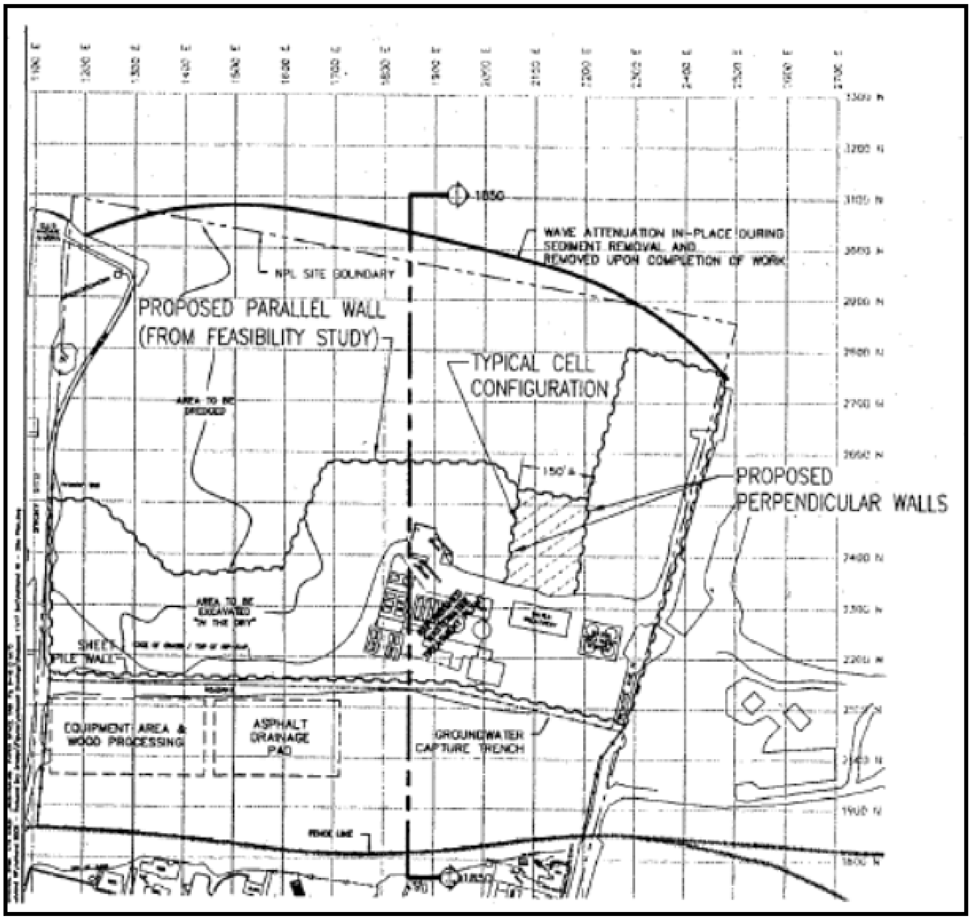


**Figure 5-1: Proposed Sheet Pile Cells (From Weston Memo)**

In addition to dramatically increasing costs, the proposed sheeting system also creates new technical issues because the proposed perpendicular sheet pile walls will create zones where contaminated materials that may otherwise have been removed are not removed due to obstructions created by the containment system. Driving all of the sheeting will result in otherwise avoidable fractures and penetrations into the Miller Creek Formation along its thinnest and most vulnerable shoreline alignment, thereby increasing risks associated with migration of contamination between the Miller Creek Formation and the underlying Copper Falls Aquifer.

## 5.6 COMMUNITY ACCEPTANCE ISSUES

EPA stated that during the public comment period on the PRAP, the community expressed a few concerns with the proposed remedy for the Ashland Site, but overall expressed strong support for EPA's preferred alternative. The City of Ashland provided its response to the Proposed Plan in a letter to the EPA Community Involvement Coordinator, dated August 11, 2009. In general, the community raised concerns with the cost of the cleanup, but also expressed the desire that"....the cleanup be done once and done right. It is important that the cleanup be protective of human health and the environment." Concerns were also expressed about basal heave associated with dry dredge, and the City stated that "if proven, wet dredging may be a more cost effective method. "Finally, the City expressed concern about the safety of the neighbors that will be exposed to emissions during the remediation. In addition, NSPW and its consultants expressed concerns with implementing a dry excavation sediment alternative based on engineering and cost considerations.

EPA does not address the magnitude of impacts to the community that will be experienced during a dry excavation. Dry dredging will be a multi-year endeavor and will not result in a superior product. This approach has the unfortunate consequence of maximizing both the intensity and duration of public exposures to fugitive emissions and airborne contaminants. Furthermore, the lengthened schedule results in greater disruption of public facilities and services (closed marina, closed boat launch, closed RV Park, etc.) due to multi-year schedule and the intensity of associated emissions.

## 5.7 RECONCILING EPA'S COMPARATIVE ANALYSIS

EPA indicates that the near shore dry dredge scenario is the most effective alternative without consideration to the following issues and concepts associated with a dry dredge:

- Increased risk of short-term exposure to workers and the community;
- Increased construction duration;
- Increased difficulty to implement;
- Increase in media requiring treatment though generation of millions of gallons of contaminated lake water requiring treatment;
- Increased potential for long-term failure due to the potential for basal heave and mobilization of the otherwise stable NAPL plume in the Copper Falls;
- No increased in overall protectiveness or long-term effectiveness; and
- Increased costs with no associated increase in protection.

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# 6.0 APPLICABILITY OF PRECEDENT SITES

## 6.1 BACKGROUND

In EPA's Responsiveness Summary, contained in Appendix A of the ROD, EPA listed seven example sites where dry excavation occurred and indicated that there are commonalities between the Ashland Site and the seven listed examples. Only limited descriptions on five of the examples and slightly more detailed descriptions on the remaining two of the example sites were provided. Based on our review of the samples cited by EPA, the EPA's conclusion that these examples sites indicate that "dry excavation has been used successfully around the world in both large and small water bodies, including Lake Superior " is not sufficient justification for requiring dry excavation at the Ashland Site.

The physical setting and environmental characteristics of the example sites differ materially from those at the Ashland Site. The assessment was conducted to explain how EPA's example sites differ from the Ashland Site and demonstrates that the EPA's dry excavation plan is neither conclusively supported by the examples listed in the Responsiveness Summary nor additional example sites cited herein. These additional example sites were not cited by EPA's Responsiveness Summary; however, they represent work completed in similar physical settings and scales to that planned at the Ashland Site. As such, they offer lessons learned that should be considered. Finally, the Burns & McDonnell team also evaluated precedent from a broad list of sediment related work as reported by the Sediment Management Working Group (SMWG) Major Contaminated Sediment Site Database to extract high level "lessons" from national precedent. Brief conclusions for the seven sites in the Responsiveness Summary and the three additional sites evaluated are presented herein. More in-depth evaluations and details of the ten sites discussed in this section are included in Appendix C of this report.

There are two general categories of characteristics that formulate the review and comparisons between the Ashland site and the example sites. The first general category is comprised of physical characteristics for the site such as size, depth of water, fetch and volume of material to be removed. The second general category is comprised of environmental characteristics, such as the nature and extent of contamination, discharge limits and the potential for contaminants to spread.

Based on a review of these peer sites, precedent shows dry excavation as proposed by EPA at Ashland would be very difficult to implement, may not be safe, and may not be as protective to human health and the environment as performing the work using an alternative technology.

## 6.2 SITES IN ROD ARE NOT REPRESENTATIVE OF CONDITIONS AT ASHLAND

Following are discussions regarding the seven sites EPA cited in the Responsiveness Summary that was included as Appendix A of the ROD. This was the first time these sites were identified, so there was no opportunity to comment on their relevancy until now. None of these are representative of the conditions at Ashland for a host of reasons that are summarized below and discussed in more detail in Appendix C. Many of the example sites discussed in the ROD are not even environmental projects, and the environmental projects presented in the ROD are generally very small streams and wetlands, so they do not match the fetch, water depth and other site conditions that exist in Ashland. However, in Section 6.3, sediment remediation sites that are relevant and worth discussing are presented.

### 6.2.1 Taconite Harbor, MN

The project appears to be a maintenance dredging exercise to keep the channel open as much as possible. The age of this project is such that technical details are not sufficiently available to develop a robust comparison to the Ashland project, although there are key differences that are described in more detail in Appendix C.

This project did not address any of the environmental aspects that must be addressed at the Ashland Site, including scour, redistribution, long-term interlock sealing or volatile emissions from the dredged material. Furthermore, the significant fetch in the Ashland bay as compared to that at Taconite Harbor make comparisons between the sites meaningless.

### 6.2.2 Eyemouth Harbor Inlet Development, UK

This project was performed to deepen the approach to the harbor and did not include environmental remediation. The scope involved re-shaping the approach to the harbor so that larger boats could enter, and it was designed to adjust for tidal influences that caused depth of water to change. The Responsiveness Summary did not elaborate on any similarities, and additional research only resulted in the many differences listed in Appendix C and the resulting conclusion that the sites are not comparable. This project did not address any of the environmental aspects that must be addressed at the Ashland Site, including scour, redistribution, long-term interlock sealing or volatile emissions from the dredged material.

### 6.2.3 Olmstead Lock and Dam on Ohio River

The Responsiveness Summary only included an aerial photo of the area, with no supporting information or rationale for comparing it to the Ashland site. This was a multi-year, federal-funded, navigational infrastructure project to facilitate construction of a permanent lock and dam structure. The referenced lock and dam was completed for improving navigation in a non-contaminated setting. While showing typical modern cellular cofferdam construction techniques in a river environment, the significant differences discussed in Appendix C that are unique to an environmental project do not make this project a proof of concept for dry excavation at Ashland. This project did not address any of the environmental aspects that must be addressed at the Ashland Site, including scour, redistribution, long-term interlock sealing or volatile emissions from the dredged material. For these reasons, the Olmstead project cannot justify dry excavation at Ashland; at best, it can serve as an example of cofferdam style construction in simple hydrogeological environments.

### 6.2.4 Montgomery Point Lock and Dam on White River

The Responsiveness Summary only included an aerial photo of the area, with no supporting information or rationale for comparing it to the Ashland site. Like the preceding example, this was a multi-year, federal-funded, navigational infrastructure project to facilitate construction of a permanent lock and dam structure. The project required that a large area in the White River be dewatered and maintained to facilitate construction of a dam and its components in the dry. In essence, a large area of the riverbed was surrounded by a secant cofferdam wall and the area inside the wall was dewatered. Dewatering occurred by pumping the water out of the enclosure into the River.

As with the Olmstead project, this lock and dam was completed for improving navigation in a non-contaminated setting. While showing typical modern cellular cofferdam construction techniques in river environment, the significant differences do not make this project a proof of concept for dry excavation at Ashland. The construction techniques used at the Montgomery Point project cannot justify dry excavation at Ashland; at best, Montgomery Point Lock and Dam can serve as an example of cofferdam style construction in simple hydrogeological environments.

### 6.2.5 Velsicol Chemical (Project 2 – Pine River)

This project was an environmental remediation performed in phases and in small increments. The project targeted 3 acres in a 25-acre area (St Louis Impoundment) of the Pine River. The depth of the impoundment ranged from 3 to 12 feet deep. The hot spot remediation was completed by driving sheet piling and using in-site stabilization over the 3 acres prior to excavation and disposal. The COCs were DDT, HBB, and PBB, which have low volatility.

The Velsicol project is very different from the proposed Ashland remediation and comparisons between the two sites are not appropriate. The physical site conditions, including fetch and the COCs are completely different between the two sites.

### 6.2.6 Bryant Mill Pond / Kalamazoo River

In the Responsiveness Summary, only a link to a website was provided, with no additional information or explanation as to how this site is similar to Ashland or why it should be considered justification for dry excavation at Ashland. The Bryant Mill Pond project was an environmental remediation where the dredging was to result in very low PCB concentrations at the cut surface. Portage Creek was temporarily diverted from its normal streambed to conduct "dry" excavation of 150,000 cubic yards of the creek bed and floodplain soils.

This dry dredge project in a mill pond is completely different than performing a dry dredge on the shore of Lake Superior, where there can be more than 10 miles of fetch, depending on wind direction. In addition, air emissions during dredging at Bryant Mill Pond were not a concern because PCBs are much less volatile than naphthalene and benzene. The dry excavation at Bryant Mill Pond cannot be credibly compared to a potential dry dredge at the Ashland Site.

### 6.2.7 Newburgh Lake / Rouge River, MI

In the Responsiveness Summary, only a link to a website was provided with no rationale for the comparison or explanation of relevancy. The remainder of the description was developed based on further research conducted by Burns & McDonnell. The dredging at Newburgh Lake was done to eliminate the excessive aquatic growth that entrained sediments. To address the aquatic growth and other water quality problems, it was necessary to remove the PCB-contaminated sediments.

Because the Lake is in a sheltered flood plain and is very small, and the COC is PCBs, it is not appropriate to use this site in a comparison to the Ashland Site. In fact, this Site is an example that promotes wet dredging using a clamshell bucket to some extent. The discussion addressed the need for clam shelling to remove large obstructions.

## 6.3 SITES THAT ARE RELEVANT OR APPROPRIATE TO DISCUSS

The Burns & McDonnell team conducted significant research, and individuals that possess expertise in dredging and sediment remediation projects worldwide, nationally and Great Lake-specific, were consulted. Site conditions and environmental components were considered. Although the Ashland project is not the first sediment remediation within the Great Lakes, it is truly unique. Based on our review of sites in the Major Contaminated Sediment Sites Database and interviews with experts, environmental projects that involve dredging in a wide open area with a large fetch and geologic conditions like the Ashland site have not been performed in the dry. Following are summaries for three sites that the Burns & McDonnell team identified as the most relevant to the Ashland site. They all involved large volumes of sediment, and sediment containing volatile constituents. However, the discussion highlights the fact that there are differences that cannot be ignored. Further details on the sites are included in Appendix C.

### 6.3.1 St Louis River/Interlake/Duluth Tar (SLRIDT), Duluth, MN

The remedial action was performed at the mouth of the river on Lake Superior. The purpose of the remediation was to remove 286,000 cy of contaminated sediments. It was also performed to restore the area for recreational use. The PRPs wanted to conduct less dredging and more capping, but EPA and Minnesota Pollution Control Agency (MPCA) did not agree. Instead, only a portion of Stryker Bay where naphthalene concentrations in sediment were very high was capped rather than dredged, due to concerns regarding potential exposure of neighbors to vapors during the remediation.

The remedy and the ROD for the SLRIDT were revised after being published to decrease the amount of dry dredging and increase the amount of wet dredging and capping to reduce emissions of COCs and the potential risk for human exposure. The work at this site demonstrates the impracticability of achieving remediation goals as stringent as those proposed at Ashland.

### 6.3.2 Grand Calumet River, Gary, IN

The project involved a 5-mile stretch of river (east branch and a small segment of the west branch) located adjacent to the US Steel plant and then south of the steel mill. The goal of the remedy at this site was mass removal of COCs, including tPAHs, PCBs and metals in sediment. The Corps of Engineers was not concerned with achieving very low concentrations at the cut surface. Water depth for dredging was 4 feet and the peak velocity was 3 feet/second. From the steel plant alone, there was an estimated 75 million gallons per day (MGD) wastewater discharge, and the total flow was estimated at 375 MGD.

The dredging plan included use of three cofferdams to divert flow in the first 1.5 miles where the river was narrower and the banks were more stable, and the contamination was the heaviest. The next 3.5 miles of river, where the river became more than 170 feet wide, wet dredging was employed.

This site points out some of the problems that anticipated for the Ashland site. The Grand Calumet project showed the difficulty associated with a 200-foot-wide dry excavation in a complex, contaminated environment.   Because Lake Superior is a much less quiescent body of water than the Grand Calumet River, it is likely that maintaining a large dry excavation would be more difficult at Ashland.

Also, at the Grand Calumet River site, the dredged materials contained high concentrations of PAHs, similar to the Ashland site where high concentrations of benzene are expected.  At the Grand Calumet River site, the air emissions resulting from dredging were more problematic during dry dredging than during wet dredging.  This underscores the exposure and nuisance issues that are created by any dry excavation approach at the Ashland site.

### 6.3.3 PG&E Shell Pond

This was an environmental remediation project that was conducted under the direction of the California DTSC.  Cleanup of the Shell Pond by Pacific Gas and Electric (PG&E) was first attempted in 2011. The project involved dredging and disposing of over 240,000 tons of petroleum-contaminated sludge from a wastewater pond in a populated area.  The clean-up involved hydraulic dredging of sludge from the lagoon and discharging the slurry of dredged material into geotubes.  The cleanup was shut down after four days of operation because air emissions from the remediation area were severe.  The cleanup is currently being re-designed to better address air emissions.

This site points out the importance of managing vapor emissions and odors at sediment sites.  Even though the remediation area was much simpler than Ashland, air emissions from remediation derailed the sediment remediation, resulting in an actual shutdown of the project.

## 6.4 REVIEW OF ADDITIONAL SITES AND LESSONS LEARNED

To supplement the precedent sites listed above, Burns & McDonnell reviewed project summaries obtained from the SMWG database.  Appendix D includes a summary table highlighting aspects of remediation efforts conducted at 51 sites.  Many of these sites also include use of CDFs.  Upon review and comparison/ contrast with the conditions at the Ashland Site, the following themes emerged.

1. At the vast majority of the sites, the areas of sediment removal were of limited extent.

2. Although several of the sites were associated with large water bodies similar to the harbor at the Ashland Site, the area of remediation tended to be shallow.  Many of these had a fetch less than

several hundred feet; this is two orders of magnitude less than the fetch in Chequamegon Bay. None of the sites took place in geographic settings where the wind could blow across stretches of open water on the order of thousands of feet as it does at Ashland.

3. Most of the sites with a dry dredge approach took place in channelized settings, where water diversion via sheet-pile or the use of a siphon was feasible. None of the dry excavation approaches discussed in the SMWG database that Burns & McDonnell reviewed took place in an area where there was a risk for causing groundwater contamination to spread as a result of dredging process, as is the case for Ashland.

4. Commonly, for removal in the dry as well as in the wet, a cap was placed to act as a new substrate. Remedies that did not involve capping commonly left residual contaminants at the surface.

5. In areas where volatile constituents were present in the sediment, steps were taken to mitigate the risk caused by exposure of proximate receptors to those volatile constituents. In the case of the St. Louis River site, the remedy was modified to minimize the risk of exposure of the neighbors to uncontrolled emissions. In a number of cases, vapor emissions from dredged sediments caused problems during remediation.

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# 7.0 CONCLUSIONS

The key take-aways from this evaluation include the following critical issues:

- A dry dredge is harmful to human health in the short-term, creating unsafe working conditions for workers in the exclusion zone due to the potential for heave, and the increased emissions associated with the dry excavation; and it is harmful to residents and businesses outside of the exclusion zone who will be exposed to noise, vapor emissions and nuisance dust;
- A dry dredge could be extremely harmful to the environment because of the potential for the stable plume in the Copper Falls Aquitard to mobilize into otherwise uncontaminated areas if heave occurs;
- Installation of a sheet pile wall in the center of the contaminant plume in the bay will be harmful to the environment because the integrity of the Miller Creek Formation will be compromised by driving the sheeting, and scour with resultant redistribution and spreading of contaminated sediment outside of the sheet pile wall will exacerbate the limits of the plume;
- Research into applicable precedent sites confirms that the site conditions at the Ashland site (including depth and fetch) indicate that wet dredge is more likely to be constructible;
- The Weston Memo did not fully address failures mechanisms associated with the dry dredge, including a complete analysis of basal heave;
- EPA presented new information in the ROD and after issuance of the ROD, leaving no opportunity for review and comment; and
- The comparative evaluation of alternatives that formulated the basis for the remedy selected in the ROD did not address basal heave and other key elements. If these had been included in the evaluation, the remedy selected for sediment would have been different.

# APPENDIX A - NEAR SHORE DRY EXCAVATION REMEDY SELECTION HISTORY

# NEAR SHORE DRY EXCAVATION – REMEDY SELECTION HISTORY

## INITIAL EVALUATION

The dry excavation alternative for sediment at the Ashland/NSP Lakefront Site was initially evaluated early during the Feasibility Study (FS) process. In accordance with the Administrative Order on Consent (AOC) and the Environmental Protection Agency (EPA) Remedial Investigation / Feasibility Study (RI/FS) guidance, Northern States Power Wisconsin (NSPW's) July 2007 Final Alternatives Screening Technical Memorandum (ASTM) presented a summary of the nature and extent of sediment contaminants. This summary was based upon the RI report, a summary of risks to human and ecological receptors identified in the risk assessment reports, the previously identified remedial action objectives (RAOs), and the Applicable, relevant and appropriate requirements (ARARs) for the Site. The alternatives were compared to the general response actions, known sediment remedial technologies and process options. These comparisons were based on the initial weighting criteria of implementability, effectiveness and relative cost. The rationale for retaining technologies was discussed, and carried forward for further consideration. Section 7.5 of the ASTM described several general response actions retained for further evaluation. These were further classified as retained alternatives SED-1 (no action), SED-2 (containment with a confined disposal facility [CDF]), SED-3 (containment with a subaqueous cap) and SED-4 (removal). For SED-4, both dredging and dry excavation technologies were retained.

Detailed analysis of the retained technologies were further evaluated in NSPW's October 2007 Revised Draft of the comparative analysis of Alternatives (CAA) Technical Memorandum.[5] Table 4-1 in this document entitled *Screening and Assembly of Remedial Technologies for Sediment* described dry excavation as:

> "…Can be effective but at very high cost for entire Site. May have applications at this Site or supplementing other removal technologies in the near shore areas, perhaps for debris removal."

The table further indicated dry excavation was retained as a component of alternatives SED-2, SED-3 and SED-4. Specific references in the text for the application of dry excavation for sediment and debris removal for these alternatives state:

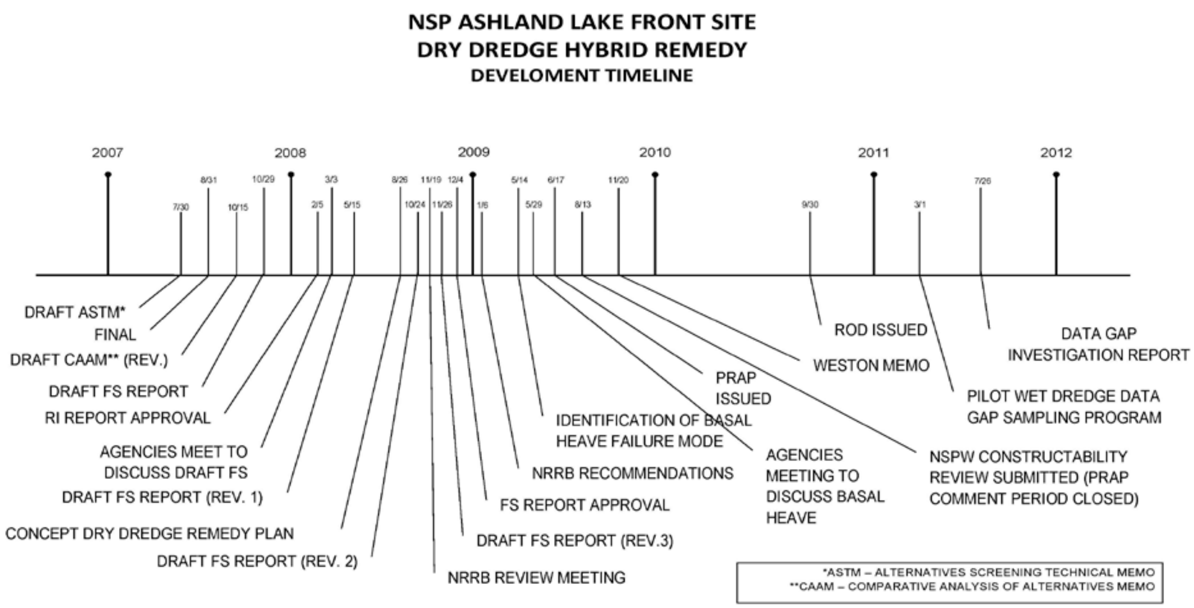
[5] No final CAA Memo was prepared or required for approval by USEPA.

> "…In some places near shore, caissons could be constructed to enable dewatering, which would allow use of shore-based excavators to remove sediment. The efficacy of this latter approach will be determined during a pilot scale project."

The CAA Memo concluded that:

> "Alternative SED-2 would provide the most long-term benefit at the least cost and with the fewest short-term technical implementation issues."

Following is a graphical timeline of the events discussed in this summary.




## FS REPORT

NSPW's initial draft FS report was submitted to the Agencies on October 29, 2007. FS level cost estimates were provided for SED-2 (CDF), SED-3 (containment with capping further subdivided by hydraulic/ mechanical dredging with or without thermal sediment treatment), and SED-4 (removal, subdivided with the same categories as SED-3). The draft FS report reiterated the conclusion of the CAA Memo recommending Alternative SED-2.

EPA provided review comments to the draft FS Report on February 15, 2008. One comment out of 215 addressed the dry excavation technology, which stated:

> "155. Section 8, Sediments: A 'dry dredge' alternative should be considered. For example, if you are willing to construct a sheet pile wall for a CDF remedy, it would also make sense to put up a sheet pile wall to help 'dry out' a portion of the bay so that it would be easier to excavate (dredge) the contaminated areas. This should be looked at as either a winter or summer alternative. The discussion should include seasonal options such as winter versus summer removal and impacts."

NSPW subsequently met with the Agencies along with their legal counsel to discuss the draft FS report on March 3, 2008. Several topics were discussed including the regulatory acceptance for the CDF [6]; however, no discussions regarding the dry excavation alternative occurred. Subsequent conference calls were also convened between the parties later that month continuing those discussions. These interactions resulted in a request by the Agencies that the FS report should be reformatted to include a new chapter integrating the affected upland and sediment areas. The purpose of this integrated approach was to provide the National Remedy Review Board (NRRB) a range of combined alternatives from which the proposed remedial plan would be developed. However, the Agencies also specified that as part of the reformatted FS report a separate dry excavation alternative should be added.

NSPW's revised draft FS report was submitted for review on May 15, 2008. It included formal responses to the Agencies' review of the initial draft. The response to comment #155 was as follows:

> *"A 'dry dredge' alternative was included only as a near shore component of a removal alternative in the Comparative Analysis of Alternatives Technical Memorandum. We eliminated it as a site-wide alternative because it was not cost effective. EPA did not comment at that time. However, the dry-dredge alternative has been added to the revised FS Report in accordance with discussions at and subsequent to the March 3, 2008 meeting."*

The revised draft FS report included the dry sediment excavation as complete dewatering and removal of the affected sediments designated as Alternative SED-5. Based on the Agencies reaction to the initial recommendation for SED-2, the revised FS report concluded that:

[6] NSPW has prepared a separate legal opinion regarding CDFs in Wisconsin waterways.

> "Alternative SED-5 is similar to SED-4 in achieving greater protection of human health and the environment. However, it was substantially more expensive than Alternative SED-4 (from approximately $25,000,000 to $33,000,000 or about 65% more expensive using similar sediment treatment) and also presents potentially greater risk to human health, because of the need to work behind barriers engineered to keep out the waters of Lake Superior and because the project duration is estimated to be at least twice as long… Based on this evaluation, Alternative SED-4 would provide the most long-term benefit at the least cost and with the fewest short-term technical implementation issues."

During review of the revised draft FS Report, the Agencies approached NSPW during August 2008 requesting it consider a hybrid remedy incorporating a combination of the wet excavation alternative (SED-4) with the dry excavation alternative (SED-5). NSPW subsequently prepared a separate analysis of this hybrid remedy (SED-6) as a dry sediment excavation area within 200 feet of the affected shoreline with wet dredging beyond, and submitted it to the Agencies on August 26, 2008. This submittal was then followed by a letter from the Wisconsin Department of Natural Resources (WDNR) to EPA providing recommendations regarding Site remedies for EPA to consider for its submittal to the NRRB on September 2, 2008. For the sediments, the WDNR recommended alternatives SED-4, SED-5 or SED-6. However, the WDNR added that a pre-design pilot test for a wet excavation remedy should be implemented to evaluate the method's ability to meet the remedial goals; in the event the pilot test failed, then dry excavation should be required.[7]

EPA provided review comments to the revised draft FS report including comments to the SED-6 analysis on September 25 and 30, 2008. EPA's transmittal letter for the review comments indicated that the Agency:

> "…invokes its right to modify the FS pursuant to Subparagraph 21(c) of the AOC). The attached FS documents provide final language changes and also include comments that need to be addressed in the final FS for the Ashland/NSP Lakefront Superfund Site."

The Agency comments to the revised draft FS report also required that the alternative SED-6 analysis be incorporated into the subsequent revised draft FS report.

NSPW's second draft of the revised FS report incorporating the latest review comments was submitted to the Agency on October 24, 2008. EPA subsequently provided a review with comments along with an

[7] NSPW submitted its recommendations to the NRRB on October 6, 2008; NSPW included rationale favoring alternative SED-4 in lieu of either dry excavation alternative SED-5 or SED-6.

edited version of this latest draft to NSPW on November 17, 2008. The review included one general comment that requested that the SED-4 costs should be recalculated to include multiple passes to meet remedial cleanup goals.

NSPW's third draft of the revised FS report incorporating the November 17th Agency review comments were submitted on November 21, 2008. EPA approved this version of the FS report (with minor modifications) on December 4, 2008. NSPW then submitted the final FS report with the latest Agency revisions for the Administrative Record on December 5, 2008.

## NRRB REVIEW

The NRRB met with EPA on November 19, 2008. It issued its remedial action recommendations to the Agency in a memorandum on January 6, 2009. EPA then submitted responses to these recommendations on May 21, 2009, indicating it:

> "…will incorporate the Board's recommendations in its Proposed Plan and ROD, as appropriate."

Regarding the dry excavation alternative, the Board's recommendation and EPA's response was as follows:

> *Dry Dredging*
>
> The Region [5] identified dry dredging as the preferred alternative for dredging the product waste distributed within the wood waste material. The Board notes the difficulty that wet dredging poses, especially in light of the associated potential for contaminant releases during the operation. Therefore, the Board supports dry dredging of the contaminated overburden material and underlying product to the extent practical (200 feet from the shoreline, as presented).
>
> Response: The Region [5] thanks the Board for its support of dry dredging for the near-shore materials in the sediment portion of the remedy.

## PROPOSED REMEDIAL ACTION PLAN

In mid May 2009, NSPW identified the potential for basal heave if the dry dredge hybrid was implemented. At a subsequent technical working group meeting with EPA and WDNR on May 29, 2009, NSPW presented concerns regarding basal heave risks associated with dry excavation. Approximately one month later, EPA issued its Proposed Remedial Action Plan (PRAP) in June 2009. The Plan described the dry excavation hybrid (alternative SED-6) as part of the overall preferred Site remedy. The Agency subsequently convened a public meeting allowing comments on the Plan on June 29, 2009.

During the meeting, NSPW presented its objections to the dry excavation plan. One of the objections raised was the potential for basal heave and the associated failure if the dry excavation plan were implemented, a condition never evaluated during the FS process. The EPA did not address the basal heave issue in the PRAP because basal heave was not explicitly addressed at the FS stage

Following the above referenced presentation at the public meeting, EPA requested NSPW respond to the PRAP regarding its concerns. In July 2009, NSPW met with EPA and DNR and informed the regulators that the dry excavation approach was unsafe, inappropriate and not acceptable to NSPW. EPA commented that they also have some concerns and would be willing to reconsider if NSPW presented its technical basis for objections. NSPW submitted a subsequent constructability review of the dry excavation component described in the PRAP to EPA on August 13, 2009, when the public comment period for the PRAP ended. In the review were topics that included basal heave, design flaws in the proposed containment system, consequent plume mobilization in the Copper Falls Aquifer and increased risk of vapor exposure. The review recommended the wet excavation alternative SED-4 in lieu of alternative SED-6.

Unknown to NSPW at the time, but as a result of NSPW's specific concern regarding basal heave, EPA also completed a more extensive evaluation of basal heave following the public meeting. EPA's review was completed by Weston and is the subject of the previously mentioned November 20, 2009 *Technical Memorandum Conceptual Geotechnical Assessment for Sediment Removal*(Weston memo). EPA did not notify NSPW of the existence of the Weston Memo. NSPW first learned of the memo because it was referenced in the ROD which was not published until over a year after NSPW's submittal of its August 13, 2009 constructability review that demonstrated the impracticability of the dry excavation approach – a demonstration that was met without any formal comments in return from EPA or WDNR.

## RECORD OF DECISION

EPA issued its Record of Decision (ROD) for the Site along with the Responsiveness Summary to the individual comments submitted in response to the PRAP in September 2010. The ROD selected the hybrid dry excavation alternative (SED-6) as the sediment remedy. The Responsiveness Summary refuted all formal objections to the alternative described in the public comments. As mentioned above, the ROD included a reference to the Weston Memo but did not include the memo itself as an appendix or attachment but EPA appears to have relied on the Weston memo to support its remedy selection. NSPW obtained a copy of the Weston memo in October 2010.

## PILOT WET DREDGE PROGRAM

Although the ROD recommended the hybrid remedy, it included a provision for a wet dredge pilot program to evaluate if cleanup standards could be met using those methods. NSPW subsequently developed a Sampling Scope of Work in February 2011, and performed sampling through the winter ice in March 2011 to collect additional data. These data were then used to prepare a Data Gap Investigation Report for a wet dredge effort and submitted it to the Agencies on July 26, 2011. Also, NSPW prepared a Pre-Design Work Plan and a Performance Standards Verification Plan (PSVP) and submitted these two documents to EPA on June 7, 2011. However the EPA rejected these documents in letters dated July 7, 2011. As a result, NSPW and the Agencies agreed to initiate negotiations to bifurcate the Ashland site, developing separate Consent Decrees (CDs) for the upland areas and offshore sediments. The upland area CD then was developed and approved on August 8, 2012. Future negotiations for the CD for the offshore sediments are pending.

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# APPENDIX B–BURNS & MCDONNELL TEAM
# (FIRM INFORMATION AND PERSONNEL QUALIFICATIONS)

## QUALIFICATIONS

The Burns & McDonnell team that prepared this report includes firms and specialized individuals within each firm that are subject matter experts. Independent consultants have also contributed to this report. The three primary firms that comprise the team include Burns & McDonnell, DCI Environmental, Inc. (DCI) and NewFields. Supporting firms on the team that provided information needed to compile this report include independent consultation by Mr. Greg Hartman of Hartman Associates and Mr. Mike Palermo of Mike Palermo Consulting and professional services related to a wave study and related modeling by RPS Evans Hamilton, Inc. (EHI) and Coast and Harbor Engineering (Coast and Harbor). Together the team is fully integrated, with exceptional capabilities. The team is second to none in successful remediation of manufactured gas plant (MGP) sites, including those that involve investigation and remediation of sediments. Following are the firm qualifications followed by the qualifications of the individuals that provided material and substantive contributions:

### PRIMARY FIRMS

**Burns & McDonnell** is a large multi-faceted engineering and construction firm with an MGP resume of over 70 sites. Since 1898, Burns & McDonnell has provided engineering and related services to utility clients throughout the Midwest and beyond. Headquartered in Kansas City, Missouri with offices nationwide, we have grown into a billion-dollar firm providing full-service engineering, architecture, construction, environmental and consulting solutions. Burns & McDonnell's multi-disciplined staff of more than 3,300 employee-owners includes engineers, geologists, scientists, architects, construction experts, planners, estimators, economists, and technicians representing virtually all design disciplines. Burns & McDonnell plans, designs, permits, constructs and manages facilities all over the world, with one mission in mind: Make Our Clients Successful.

Much of the firm's success and growth is due to its ability to conduct large, multi-faceted projects. This success is primarily the result of a corporate management philosophy that facilitates effective coordination among specialized company divisions performing different project functions. That success is also evident in Burns & McDonnell's MGP services. Burns & McDonnell has helped resolve environmental impacts from literally millions of tons of impacted soil and sediment with a risk management approach that achieves site rehabilitation goals. Burns & McDonnell provides effective solutions for all environmental media, including soil, groundwater, bedrock, and sediment. From site investigation onward, Burns & McDonnell focuses its expertise on achieving closure of the site.. Burns & McDonnell has won national honors for creative MGP remedial design solutions and leads the industry in complete MGP capabilities, from initial studies to final design-build site reclamation.

Burns & McDonnell has extensive experience investigating historical releases associated with multiple MGP sites along water bodies. These include a number of sites along the Chicago River, and in particular, the infamous Bubbly Creek segment that continues to this day to bubble furiously because of the methane from organic matter degradation in the creek. Burns & McDonnell implemented traditional investigation techniques, innovative field screening tools and forensics to speciate MGP tars from other contaminants. We have dredged thousands of cubic yards of sediment at some of these sites. We have also performed sediment removal and marine construction at other sites in Wisconsin, including the Murphy Oil refinery in Superior, where tens of thousands of cubic yards of sediment were removed.

Burns & McDonnell is managing a major sediment remediation at an MGP site in Illinois, where several hundred thousand cubic yards of sediment will be removed. Upland portions of the site are undergoing remediation at this time, and the sediment remediation portion is currently in the design stage. This is a site with a complex groundwater flow system similar to Ashland. We are in the design stage of capping oil sediment at a refinery site Kansas. At a major MGP site in Maine, we are monitoring a sediment cap in one portion of the river, investigating and evaluating cap designs for a second portion, and developing natural recovery arguments for a third portion that has a large area of hardened tar. Burns & McDonnell personnel also have experience working on sediment sites in Wisconsin, Indiana, Michigan, Pennsylvania, and New Jersey.

An integral part our sediment practice is the sediment remediation laboratory at our office in Madison, Wisconsin. We established the laboratory as a resource to aid in our evaluation of sediment site data and to assist with engineering failure analysis. The lab is used to perform physical modeling of natural and engineered systems, such as sediment caps, and the migration of viscous liquids (such as oil or MGP tar) in granular media. The remediation laboratory is not set up to perform standardized analyses in a production mode. Instead, the laboratory is designed to be a flexible resource that employs physical modeling to answer site-specific questions regarding investigation, and remediation, as well as forensic issues.

Physical modeling has allowed us to develop more meaningful estimates of parameters for which numerical models or analytical models have not yet been developed. Coupled with field observations and analytical techniques, the laboratory provided the ability to simulate complex processes that control the behavior of contaminants in the environment (such as the migration of fluids in multi-phase systems, like NAPLs in sediment). The laboratory environment facilitates bridging the gap between a desk-top analysis of a problem, and a pilot-scale field trial. Being able to examine these complex processes in the laboratory results in a focus on techniques and alternatives that are likely to succeed in the field. Identifying potential failure mechanisms for remedial alternatives is a key aspect of our work.

In addition, the laboratory can be used to develop data to answer questions among technical personnel that are currently dealt with as matters of opinion, greatly reducing the time and energy spent on “battling experts.” Physical modeling is used to analyze specific aspects of sediment systems to develop fact-based (as opposed to intuition-based) designs for sediment remediation. The great advantage of the laboratory is that it can be used to develop an understanding of site conditions that allows our clients to proceed with a known degree of confidence under conditions of uncertainty.

**DCI Environmental** is a trusted business partner for Xcel and has successfully completed work at 89 MGP sites (12in WI) as a general contractor using traditional and innovative treatment technologies. DCI was originally incorporated in 1977 to provide dust control and road stabilization services. In the early 1980’s the company expanded to provide emergency response services for train derailments and tanker trucks. In addition, the company became involved in underground tank removal and tank cleaning. With this experience, DCI was able to beneficially reuse this waste stream (sludge) and blend it with coal for use as alternative fuels.

In 1987, DCI expanded its capabilities to provide Low Temperature Thermal Desorption (LTTD) of petroleum-contaminated soils. DCI has utilized this process throughout the country from the Florida Everglades to Seattle, Washington. DCI has also commissioned a Medium Temperature Thermal Desorption (MTTD) 6 million dollar facility in the Czech Republic to provide thermal desorption services for the first MGP site cleanup. DCI has successfully completed projects for the Department of Defense (Air Force, Army, and Navy), EPA Regions 4, 5, 7, and 8, large transportation companies (BN&SF, Boeing, C&NW, Soo Line), major oil companies (BP/Amoco, Texaco, Conoco/Phillips, and Mobil Oil), and utility companies (MidAmerican Energy Company, Alliant Energy (Wisconsin Power & Light, Iowa Electric Services, and Interstate Power Company), Northwest West Public Service, Center Point Energy (Minnegasco), We Energies (Wisconsin Electric Power Company and Wisconsin Gas Company), Wisconsin Public Service, Xcel Energy, and Kansas Gas Company.

DCI has twenty-two years of multiple disciplined civil earthwork, thermal desorption, and soil stabilization experience and it’s personnel offer more than 90 years of combined civil and thermal processing experience (2,800,000 tons aggregate, contaminated soil remediation experience).This brings a diverse background of expertise in such areas as excavation, sheeting/shoring, harbor mechanical excavation/ dredging, drilling caissons, pile driving, site development, demolition, roadway grading, and the design/build of desorbers, burners, baghouses, and other material handling equipment.

**NewFields** is an international firm of environmental experts in the fields of engineering, life sciences and environmental medicine. The firm provides comprehensive services for the resolution of all aspects of environmental liabilities, focusing on environmental stewardship. NewFields practitioners are individually recognized in their respective fields and were assembled from a world class pool of talent. NewFields offers a spectrum of services focused on toxicology, public health and occupational medicine for governmental, multilateral agencies and corporate clients throughout the world. NewFields' multi-disciplinary team is experienced in toxicology and multi-media risk assessment, complex impact assessments that include environmental, social, health and human rights. NewFields has specific expertise in forensic chemistry, Natural Resource Damage, contaminated sediment management, groundwater modeling, river science and engineering and hydraulic network modeling.

NewFields Environmental Forensics Practice group specializes in the diagnostic measurement of tar, coke, coal, petroleum, chlorinated chemicals, and other industrial products in various environmental media. NewFields has participated in more than fifty source identification projects involving the identification of petroleum tar and coal tar generated by carbureted water gas, oil gas, and coke ovens facilities. The historical practices at these sites included the manufacture, storage and distribution of chemical products from MGPs, wood treatment plants, metallurgical industries, general construction, municipal installations, military bases, utilities and waste sites of many varieties.

NewFields health professionals serve on a variety of international scientific committees and publish widely in the peer reviewed scientific literature. In addition, NewFields has authored technical guidance documents covering numerous areas of public health, toxicology, risk assessment and occupational medicine. NewFields has active projects and professionals working on six continents.

## SUPPORTING FIRMS

**EHI** is a full-service oceanographic and marine instrumentation company with a reputation for excellence in physical oceanography services, meteorological condition studies and applied marine and instrumentation services. EHI performed the wave studies at the Site and worked with Coast and Harbor on the modeling associated with installation of a cofferdam in the bay and the anticipated behavior of the water and sediment around it.

Established in 1971, EHI has locations in Texas, Washington and South Carolina. From these locations, EHI provides international project support for projects involving coastal and riverine environments, model calibration and impact assessments. The staff at EHI has measured coastal processes around the world for more than 30 years using state-of-the-art techniques, providing clients with accurate and reliable data.

EHI has expertise in performing current and wave studies and possess specialized equipment that is used to collect various data about marine conditions.  Coastal processes such as wind, current, tides and water fluctuations all contribute to a changing coastal environment, and an understanding of their effects helps predict and prepare for the future. Circulation studies show the distribution of sediments and help predict the likely location of concentrations over time. Through the expert deployment of specialized instrumentation, EHI scientists conduct start-to-finish studies that enhance knowledge and understanding of coastal environments.  Also, EHI has expertise in performing tracer studies to track sediment and report on its source and movement over different time periods. These types of studies are frequently commissioned for projects involving construction and maintenance of harbors and other structures.

**Coast and Harbor** specializes in coastal, navigational and dredging projects.  Coast & Harbor engineers specialize in analyzing coastal physical processes and their effects on coastal zone and waterfront projects. Waves, currents, and sediment and contaminant transport are analyzed and simulated for assessing project feasibility and for planning, permitting, and design. Coast & Harbor engineers routinely develop, verify and apply sophisticated numerical modeling tools and analysis techniques. These capabilities are applied to quantify and display physical effects on the project, and minimize project effects on the environment.

Coast & Harbor has ongoing coastal and hydraulic engineering projects throughout the United States and overseas (Russia, Mexico, South Korea, Guinea, India, Persian Gulf, Jordan, Haiti, Bahamas, Colombia, Panama, Jamaica, and Bermuda). In addition to expertise in coastal process analysis and numerical modeling, Coast and harbor possess expertise in the following areas: shoreline protection/stabilization; costal habitat restoration; dredging and dredge material disposal design; and design of harbors, marine terminals, and marinas.

Coast & Harbor focuses its wealth of experience on clients' needs and the project's environmental setting to design cost-effective, permittable, and constructible coastal projects. The team of coastal professionals has worked together for years, producing advanced analysis, sophisticated modeling technology, and innovative designs.

## PERSONNEL

### Mr. Matt Cox, PE, PG - Burns & McDonnell

Mr. Cox brings over 14 years of experience to the environmental consulting business, and he is a PE and a PG in several states, including WI. He has managed investigation and remediation activities at MGP sites throughout the mid-west. He has specialized in evaluating the environmental fate and transport of contaminants at MGP, hazardous waste, and petroleum contaminated sites.

### Mr. Gene McLinn, PG - Burns & McDonnell

Mr. McLinn brings 25 years of experience in environmental consulting at over 100 sites in 20 states. Mr. McLinn's project management portfolio includes a broad range of industrial sites, including MGPs with VOCs and persistent organic compounds. Over the last 12 years, he has focused on the investigation and remediation of oily sediments, including MGP tars and petroleum. He has performed original research on the interaction of sediment capping materials with gas, NAPLs, water in the capped sediment, and continues that work at our laboratory in Madison, Wisconsin. He is co-inventor for two sediment capping techniques that have patents pending, including a design that was constructed and won the Grand Award from the Wisconsin ACEC. He has given invited presentations at national conferences and to state and federal regulatory agencies, universities, and the Army Corps of Engineers. He designed and oversaw construction of dredging and capping remedy at a major sediment site on the Penobscot River in Maine. He performed research to characterize NAPL migration from tarry sediments in a heavily impacted industrial setting on the Grand Calumet River Indiana. He also evaluated the significance of NAPL migration, including MGP tar and other oils, from sediment at a site with a long industrial history along the Hudson River. In addition, he designed and oversaw a series of field investigations to provide pre-design data for a sediment cap to stop petroleum from seeping into a river in an urban setting in Pennsylvania, and to prevent MGP tar from migrating from sediment at a site on the Huron River in Michigan.

### Dr. Mike Palermo, PhD, PE – Mike Palermo Consulting, Inc.

Dr. Palermo is a consulting engineer with extensive internationally recognized experience in dredged material management and contaminated sediment remediation. For the majority of his career, Dr. Palermo served with the USACOE as a Research Civil Engineer and Director of the Center for Contaminated Sediments at the Engineer Research and Development Center (ERDC) at the Waterways Experiment

Station (WES), where he managed and conducted both research and applied studies for the USACE, EPA, DOJ, NOAA, U.S. Navy, and others. He also managed the WES/ERDC research focus area for contaminated sediments. Since entering private practice in 2003, he has provided design services and technical review and oversight for clients, both in the U.S. and abroad, on a wide range of sediment remediation and navigation projects involving contaminated sediments including sediment mega-sites such as the Hudson River, Housatonic River, Fox River, Portland Harbor, and Onondaga Lake.

### Mr. Pete Burton, PE - Burns & McDonnell

Mr. Burton has over 24 years of experience in geotechnical engineering and foundation design. He serves as the senior geotechnical reviewer for Burns & McDonnell and he has expertise in the design of earth retention systems, earthen dams, cofferdams and marine structures.

### Margaret Kelley, PE - Burns & McDonnell

Ms. Kelley has over 25 years of consulting experience and has successfully managed the investigation, remediation and closure of several MGP sites; many of them on water bodies in IL. She also has extensive experience in engineering design and in the Superfund RI/FS and RD/RA processes in Regions 5, 2, 4 and 7.

### Mr. Mike Swieca, PE, PMP - Burns & McDonnell

Mr. Swieca has over 25 years of experience in environmental system design and construction, environmental remediation and construction management. He has led the field activities on numerous MGP remediation sites that have been successfully closed under various regulatory programs. He has expertise in estimating construction project sequencing, tracking and scheduling associated with construction projects, including those within water bodies.

### Mr. David Trainor, PE, PG - NewFields

Mr. Trainor has over 32 years of experience in numerous environmental projects and investigations, which include both federal (NPL, RCRA and removal action programs) and state-lead projects. Categories include RI/FS programs, geotechnical testing and analyses, groundwater assessments, disposal facility siting and design, groundwater remedy systems, and construction management. Mr. Trainor is currently providing third party review of the contaminant contribution methodologies proposed for the PRPs at the Fox River and Sheboygan River Superfund sites. He also represented NSPW at the Ashland Site as the technical lead for the initial investigations begun in the mid-1990s through the RI/FS.

### Dr. Jack Word, PhD - NewFields

Dr. Word has degrees in Zoology, Biology and Fisheries and he has over 35 years of pioneered research on aquatic toxicology. His fields of expertise include: toxicology; development of testing protocols; petroleum-related issues; dredge material and sediment evaluations; benthic community interpretation and studies; sea surface micro layer sampling and testing and he is the developer of the innovative bioremediation technology called MycoRemediation.

### Mr. Greg Hartman, PE - Hartman Associates, LLC

Mr. Hartman has over 40 years of professional experience in coastal and river engineering, dredging and disposal, capping and confinement. He has focused on Port channel and waterway development, and environmental engineering for sediment remedial design . He has provided the engineering and construction expertise for navigation and remediation dredging, disposal and capping throughout the USA. He has also completed navigation design, dredging and disposal projects overseas. He has been an instructor for the U.S. Army Corps of Engineers primary training program on dredging, *Dredging Fundamentals,* since 1985.

### Mr. Frank Kellogg - DCI Environmental, Inc.

Mr. Kellogg has managed administratively and operationally (including Program and Project Management) approximately 105 contaminated sites across the county consisting of petroleum hydrocarbons, chlorinated solvents, PCBs, herbicides and pesticides, dioxins, wood treating creosote, and MGP coal tar and carbureted water gas tar waste. In the past 23 years, he has Program, Project, and Co-Project Managed 89 MGPs, wood treating and herbicide and pesticide sites during RI/FS, design and implementation of civil construction and remedial activities, with an emphasis on design-build and has remediated over 2 million tons of MGP/PAH contaminated media for various Utility and wood treating clients directly.

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# APPENDIX C -
# DETAILS ON PRECEDENT AND EXAMPLE DREDGE SITES

# DETAILS ON PRECEDENT AND EXAMPLE DREDGE SITES

Seven sites that EPA listed in the Responsiveness Summary, included in Appendix A of the ROD and three sites that Burns & McDonnell identified as relevant for comparison to the Ashland Site were summarized in Section 6 of the report. Following are more detailed discussions on these sites. First the seven sites that EPA identified are discussed and then the other three are discussed. Also, Appendix D contains an even broader list of sites that Burns & McDonnell reviewed in an effort to find similarities to the Ashland Site. The conclusion is that environmental dry dredging in the open waters of the largest fresh water lake in the world is unprecedented.

## EPA SITES IN THE ROD

### Taconite Harbor, MN

**<u>Purpose/Setting/Description</u>**: The project appears to be a maintenance dredging exercise to keep the channel open as much as possible. EPA describes this site as a place where "much of the excavation …was carried out in a dry dredge scenario using sheet piles to hold back Lake Superior". No other details were provided by EPA, and it is not clear how much of the excavations were performed in the dry. Excavations occurred in the Taconite Harbor in the 1950's and 1960's, as shown in the photo of sheet piling and soil/sediment with ponded water. Burns & McDonnell's research concluded that this harbor handled iron ore, iron ore pellets, coal and fluxstone, and was operated by Cliffs Erie, LLC. The pier is over 2,300 feet long and the water depth is approximately 30 feet. Craig Hartmann of Cliffs Erie, LLC was contacted regarding the details of the project. His information, as well as the details regarding the pier, was published in the report *Minnesota's Lake Superior Terminals*, assembled by the Ports and Waterways Section of the Minnesota Department of Transportation, dated April 2011. He did not recall the project, and the terminal is almost shut down, but Mr. Hartmann recalled significant maintenance dredging to keep the channel open in the busy season. He was unaware of any past or ongoing environmental projects.

The age of this project is such that technical details are not sufficiently available to develop a robust comparison to the Ashland project, although there are several key differences that can immediately be identified that confirm that this site is much different than the Ashland Site.

- Taconite Harbor was not an environmental remediation project where the dredging was supposed to result in very low concentrations at the cut surface.
- Volatile emissions from dredge spoils were not an issue.
- Scour or redistribution of sediments associated with installing a sheet pile wall was not a concern.

- There was no NAPL plume adjacent to the site that could potentially be mobilized as a consequence of a large dewatering effort, as is the case at the Ashland Site.
- Sheeting interlock integrity was not a significant concern.
- Interlock materials that had to withstand anything other than water were not included in the design.

**What is the lesson/point:** Although EPA has cited this example as one of sheeting being used at a site in Lake Superior, there are no other similarities to the Ashland Site. This project did not address any of the environmental aspects that must be addressed at the Ashland site, including scour, redistribution, long-term interlock sealing or volatile emissions from the dredged material. Furthermore, the significant fetch in the Ashland bay as compared to that at Taconite Harbor make comparisons between the sites meaningless.

## Eyemouth Harbor Inlet Development, UK

**Purpose/Setting/Description:** This project was performed to deepen the approach to the harbor and did not include environmental remediation. The scope involved re-shaping the approach to the harbor so that larger boats could enter, and it was designed to adjust for tidal influences that caused depth of water to change. The Burns & McDonnell team is not aware of sediment contamination issues at this site and it appears to be a traditional civil mass removal dredging effort, similar to the Taconite harbor project. The dredging was a long narrow cut, so the fetch was short. Also, there was no concern with re-distribution, scour, and long-term interlock sealing.

From the available information, this site is not comparable to the Ashland project for the following reasons:

- Eyemouth Harbor was not an environmental remediation project where the dredging was supposed to result in very low concentrations at the cut surface.
- Volatile emissions from dredge spoils were not an issue.
- There was no NAPL plume adjacent to the site that could potentially be mobilized as a consequence of a large dewatering effort, as is the case at the Ashland Site.
- Scour or redistribution of sediments associated with installing a sheet pile wall was not a concern.
- Sheeting interlock integrity was not a significant concern.
- Interlock materials that had to withstand anything other than water were not included in the design. The fetch and potential for wave forces was less significant on a long narrow dredge cell than in open water such as at Ashland.

**What is the lesson/point:** For the many reasons stated above, this site cannot be compared to performing a dry dredge at the Ashland Site. The Responsiveness Summary did not elaborate on any similarities, and additional research only resulted in the many differences listed above and the resulting conclusion that the sites are not comparable.

## Olmstead Lock and Dam on Ohio River

**Purpose/Setting/Description:** The Responsiveness Summary only included an aerial photo of the area, with no supporting information or rationale for comparing it to the Ashland site. This was a multi-year, federal-funded, navigational infrastructure project to facilitate construction of a permanent lock and dam structure. The project required that a large area in the Ohio River be dewatered and maintained to facilitate construction of a dam and its components in the dry. In essence, a large area of the riverbed was surrounded by a secant cofferdam wall and the area inside the wall was dewatered. Dewatering occurred by pumping the water out of the enclosure into the Ohio River. Some of the outer sheeting wall was integrated into the final structure.

This project is not like the Ashland project for the following reasons:

- Olmstead Lock and Dam was not an environmental remediation project where the dredging was supposed to result in very low concentrations at the cut surface.
- Volatile emissions from dredge spoils were not an issue.
- Scour or redistribution of sediments associated with installing a sheet pile wall was not a concern.
- There was no NAPL plume adjacent to the site that could potentially be mobilized as a consequence of a large dewatering effort, as is the case at the Ashland site.
- Sheeting interlock integrity was not a significant concern.
- Interlock materials that had to withstand anything other than water were not included in the design.
- The fetch and potential for wave forces is less significant in a dredge cell in a river channel than in open water such as at Ashland.
- Dewatering of the dam project was accomplished by removing the water from the enclosed area and directly discharging it to the opposite side of the cofferdam without treatment. Treatment of all water before discharge will be required at the Ashland site.
- Construction of the lock and dam structure in the Ohio River could not occur any other way, whereas alternate methods for sediment removal are feasible at Ashland, such as mechanical and hydraulic dredging, which will be far less costly and pose less risk to human health and the environment.

**What is the lesson/point:** The referenced lock and dam was completed for improving navigation in a non-contaminated setting. While showing typical modern cellular cofferdam construction techniques in a river environment, the significant differences listed above do not make this project a proof of concept for dry excavation at Ashland. For the many reasons presented above, the Olmstead project cannot justify dry excavation at Ashland; at best, it can serve as an example of cofferdam style construction in simple hydrogeological environments.

## Montgomery Point Lock and Dam on White River

**Purpose/Setting/Description:** The Responsiveness Summary only included an aerial photo of the area, with no supporting information or rationale for comparing it to the Ashland site. Like the preceding example, this was a multi-year, federal-funded, navigational infrastructure project to facilitate construction of a permanent lock and dam structure. The project required that a large area in the White River be dewatered and maintained to facilitate construction of a dam and its components in the dry. In essence, a large area of the riverbed was surrounded by a secant cofferdam wall and the area inside the wall was dewatered. Dewatering occurred by pumping the water out of the enclosure into the River.

This project is not like the Ashland project for the following reasons:

- The Montgomery Point Lock and Dam was not an environmental remediation project where the dredging was supposed to result in very low concentrations at the cut surface.
- Volatile emissions from dredge spoils were not an issue.
- Scour or redistribution of sediments associated with installing a sheet pile wall was not a concern.
- There was no NAPL plume adjacent to the site that could potentially be mobilized as a consequence of a large dewatering effort, as is the case at the Ashland site.
- Sheeting interlock integrity was not a significant concern.
- Interlock materials that had to withstand anything other than water were not included in the design.
- The fetch and potential for wave forces is less significant in a dredge cell in a river channel than in open water such as at Ashland.
- Dewatering of the dam project was accomplished by removing the water from the enclosed area and directly discharging it to the opposite side of the cofferdam without treatment. Treatment of all water before discharge will be required at the Ashland site.
- Construction of the lock and dam structure in the White River could not occur any other way, whereas alternate methods for sediment removal are feasible at Ashland, such as mechanical and

hydraulic dredging, which will be far less costly and pose less risk to human health and the environment.

**What is the lesson/point:** As with the Olmstead project, this lock and dam was completed for improving navigation in a non-contaminated setting. While showing typical modern cellular cofferdam construction techniques in river environment, the significant differences listed above do not make this project a proof of concept for dry excavation at Ashland. For the many reasons presented above, the construction techniques used at the Montgomery Point project cannot justify dry excavation at Ashland; at best, Montgomery Point Lock and Dam can serve as an example of cofferdam style construction in simple hydrogeological environments.

## Velsicol Chemical (Project 2 – Pine River)

**Purpose/Setting/Description:** This project was an environmental remediation performed in phases and in small increments. The project began as a Time-Critical Removal Action that targeted 3 acres in a 25-acre area (St Louis Impoundment) of the Pine River. The depth of the impoundment ranged from 3 to 12 feet deep. The hot spot remediation was completed by driving sheet piling and using in-site stabilization over the 3 acres prior to excavation and disposal. The non-stabilized volume of material that was removed was 21,500 cubic yards (cy) and the stabilized material was 35,000 cy. The COCs were DDT, HBB, and PBB, which have low volatility.

To manage dewatering, a settling basis was constructed to accept discharge water prior to treatment and ultimate discharge under a National Pollutant Discharge Elimination System (NPDES) permit. No concern associated with driving sheeting within an area of contamination was discussed, including the potential for redeposition of contaminants in sediment on the outside face of the wall due to a change in the configuration.

In the larger Velsicol project, the river basin was subdivided using sheet pile cofferdams. During the remediation, EPA recognized that dry excavation would not be possible throughout the project area. In one year, less than 50,000 cy of sediment was removed. Also, flooding caused the project that began in 1999 to extend to a completion date of 2002. Dredging and excavating were still occurring in 2004, and EPA changed the completion date to 2009, due to insufficient funds. The complexity of attempting to perform this project led to numerous delays.

The Velsicol site differs from the Ashland site in several key respects:

- The COCs at this site are DDT, HBB, and PBB, all of which have low volatility, as compared to benzene and naphthalene, which are the COCs at the Ashland site.
- The area dredged was not deep, nor was it subjected to wave forces such as those at Ashland harbor.
- There was no NAPL plume adjacent to the site that could potentially be mobilized as a consequence of a large dewatering effort, as is the case at the Ashland site.

**What is the lesson/point:** The Velsicol project is very different from the proposed Ashland remediation and comparisons between the two sites are not appropriate. The physical site conditions and the COCs are completely different between the two sites.

## Bryant Mill Pond / Kalamazoo River

**Purpose/Setting/Description:** In the Responsiveness Summary, only a link to a website was provided, with no additional information or explanation as to how this site is similar to Ashland or why it should be considered justification for dry excavation at Ashland. The Bryant Mill Pond project was an environmental remediation where the dredging was to result in very low PCB concentrations at the cut surface. This project is Operable Unit -1 (OU-1) of five separate OUs. It is referred to as the Allied Paper Property/Bryant Mill Pond Area, and the major contaminant is PCBs. The entire Upper River Site begins at Portage Creek and extends to the Allegan Dam, in Allegan, MI. The Removal Action began in June 1998. Portage Creek was temporarily diverted from its normal streambed to conduct "dry" excavation of 150,000 cubic yards of the creek bed and floodplain soils. Excavation work was completed in May 1999.

The area is shown during remediation and after remediation and restoration in the following three photos. It is clear that this site was different from the Ashland project, since Bryant Mill Pond is in a sheltered floodplain area.

This project is different from the Ashland project for the following reasons:

- The COCs at this site are PCBs which have low volatility, and not volatile constituents such as benzene and naphthalene, as is the case at Ashland.
- The area dredged was not deep, nor was it subjected to wave forces such as those at Ashland harbor.
- The area is shown during remediation and after remediation and restoration in the following three figures. It is clear that this site was different from the Ashland project, since Bryant Mill Pond is in a sheltered floodplain area, whereas Ashland is on the shore of Lake Superior.

**Figure C-1: Kalamazoo River Project Photos**

**<u>What is the lesson/point:</u>** This dry dredge project in a mill pond is completely different than performing a dry dredge on the shore of Lake Superior, where there can be more than 10 miles of fetch, depending on wind direction. In addition, air emissions during dredging at Bryant Mill Pond were not a concern because PCBs are much less volatile than naphthalene and benzene. The dry excavation at Bryant Mill Pond cannot be credibly compared to a potential dry dredge at the Ashland Site.

### Newburgh Lake / Rouge River, MI

**<u>Purpose/Setting/Description:</u>** In the Responsiveness Summary, only a link to a website was provided with no rationale for the comparison or explanation of relevancy. The remainder of the description was developed based on further research conducted by Burns & McDonnell. The dredging at Newburgh Lake was done to eliminate the excessive aquatic growth that entrained sediments. To address the aquatic growth and other water quality problems, it was necessary to remove the contaminated sediments. This led to the Newburgh Lake Restoration Project which focused on the following objectives:

- Eliminate PCB fish advisory
- Enhance water quality

- Enhance recreation

Newburgh Lake was created in the early 1900s as a recreational setting by impounding a portion of the Rouge River. Over the years, sediments accumulated in the impoundment, which significantly degraded the recreational quality of Newburgh Lake. Shallow water depths of less than 4 feet resulted from the sediment accumulation, and nutrient-rich water led to excessive growth of aquatic plants. Moreover, some of these sediments contained PCBs. Planning for the restoration project began in 1993 followed by the final design in 1996, with construction starting in April 1997 and completion in October 1998.

Only winter excavations were completed in the dry, once the ground surface stabilized. The majority of this lake was excavated in the wet. Also, the design basis report that was prepared for this site indicated that wet dredging with a clamshell bucket was needed, due to the amount of debris and obstructions on the sediment surface that prohibited hydraulic dredging. The Lake, which was approximately 3.9 feet deep on average, was deepened to a minimum of 8 feet, except for designed vegetation areas.

From the available information, and as depicted in the figures inserted below, this site was different from the Ashland project for the following reasons:

- This lake is very small, created by impounding a river, and strong storms could not create waves similar to what may be expected in Lake Superior.
- There was no NAPL plume adjacent to the site that could potentially be mobilized as a consequence of a large dewatering effort, as is the case at the Ashland site.
- Newburgh Lake was an environmental remediation project where the dredging was supposed to result in very low concentrations at the cut surface, but Newburgh Lake is in a sheltered floodplain area and the sediments contained no volatile constituents.

**What is the lesson/point:** For the reasons stated above, it is not appropriate to use this site in a comparison to the Ashland Site. In fact, this Site is an example that promotes wet dredging using a clamshell bucket to some extent. The discussion addressed the need for clam shelling to remove large obstructions.

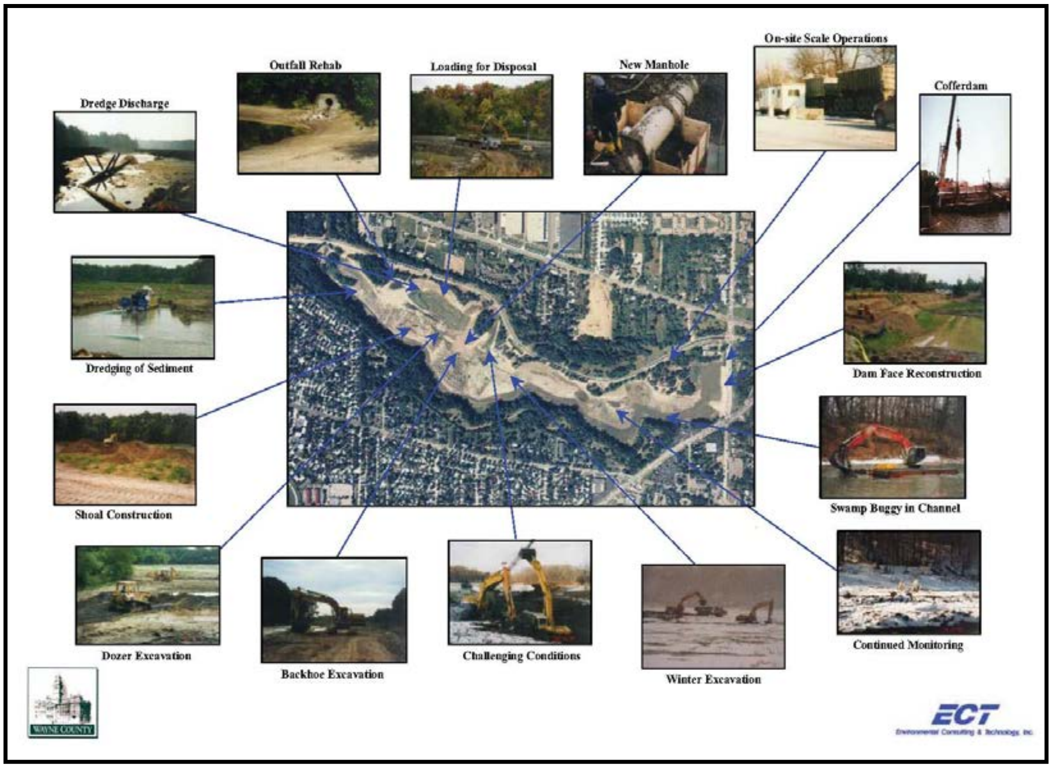


**Figure C-2: Newburgh Lake / Rouge River Project Photos**

## SITES THAT ARE RELEVANT OR APPROPRIATE TO DISCUSS

Following are discussions regarding the three sites that the Burns & McDonnell team identified as the most relevant to the Ashland site. They all involved large volumes of sediment, and sediment containing volatile constituents. However, the discussion highlights the fact that there are differences that cannot be ignored.

### St Louis River/Interlake/Duluth Tar (SLRIDT), Duluth, MN

**Purpose/Setting/Description:** The remedial action was performed at the mouth of the river on Lake Superior. The purpose of the remediation was to remove 286,000 cy of sediment exceeding the remediation goals established by EPA. It was also performed to restore the area for recreational use. This project was located in an area of mixed residential and industrial land use. The remediation area consisted of a35-acre embayment (Stryker Bay), a 23-acre boat slip (Slip 6) and a 27-acre boat slip (Slip7). The average total PAH (tPAH) concentration in sediment in the embayment was 2,160 ppm. The potentially responsible parties (PRPs) wanted to conduct less dredging and more capping, but EPA and Minnesota Pollution Control Agency (MPCA) did not agree. Instead, only a portion of Stryker Bay where naphthalene concentrations in sediment were very high was capped rather than dredged, due to concerns regarding potential exposure of neighbors to vapors during the remediation.

MPCA advocated dredging because it was concerned that there were no known cases where a 6-inch thick cap for the post-remediation surface was protective for contaminated sediments. It reasoned that because the newly-remediated bay would likely attract swimmers and boats, the resulting recreational activities and prop wash would disturb the cap. The on-shore wetland area clean up goal was 13.7 ppm; any areas where concentrations exceeded this level were capped. Emissions and dredged residuals were easier to manage at the dredge head for the hydraulic dredge than for a mechanical dredge.

This site has several similarities to the Ashland Site, including the following:

- The two sites are on the same body of water, approximately 60 miles from one another. Both sites are former MGPs, remediated under EPA.
- Stryker Bay site has a similar geometry to Ashland with a broad bay, even though Stryker Bay is shallower than Ashland, and it opens to the St. Louis River instead of Lake Superior. However, Stryker Bay is basically a sheltered, inland, body of water.
- The initial 1999 ROD for the SLRIDT site was set aside and re-created to include wet dredging on portions of the water. The revised ROD identified a total of 286,000 cy of sediment exceeding the remediation goal of 6 ppm total carcinogenic PAHs and 40 ppm total PAHs to be addressed. (On the Ashland site, no differentiation is made between carcinogenic and total PAHs. The remediation goal at Ashland is more stringent, with 9.5 mg/kg tPAHs based on a surface-weighted average, and a 22 mg/kg not-to exceed).
- The SLRIDT remedy was adapted to minimize volatile emissions during remediation (contaminated sediment capped in place instead of being removed).
- There was no NAPL plume adjacent to the site that could potentially be mobilized as a consequence of a large dewatering effort, as is the case at the Ashland site.
- The primary difference between the sites is the fact that the dredging at SLRIDT took place in a much more sheltered area than Ashland.

**What is the lesson/point:** The remedy and the ROD for the SLRIDT were revised after being published to decrease the amount of dry dredging and increase the amount of wet dredging and capping to reduce emissions of COCs and the potential for human exposure. The work at this site demonstrates the impracticability of achieving remediation goals as stringent as those proposed at Ashland. .

## Grand Calumet River, Gary, IN

**Purpose/Setting/Description:** The goal of the remedy at this site was mass removal of COCs, including tPAHs, PCBs and metals in sediment. The Corps of Engineers was not concerned with achieving very low concentrations at the cut surface. The Area of Concern (AOC) was a five-mile-long stretch of river adjacent to the US Steel Gary Works to the south. Water depth for dredging was 4 feet and the peak velocity was 3 feet/second. From the steel plant alone, there was an estimated 75 million gallons per day (MGD) wastewater discharge, and the total flow was estimated at 375 MGD.

The sources of contamination to the river, aside from the steel plant, included non-point source runoff from industry, as well as over 150 leaking underground storage tanks (LUSTs) and Resource Conservation and Recovery Act (RCRA) sites. COCs in the sediments included PAHs, PCBs and metals. Air emission exceedences were identified in the summer of 2003 during dry dredging, whereas the emissions were decreased during wet dredging.

A total of 2,000 tons of tPAHs and 220 tons of cPAHs were removed from the AOC. A total of 687,000 tons of sediment were dredged and placed in a Corrective Action Management Unit (CAMU) on US Steel property. The dredging plan included use of cofferdams to divert flow in the first mile where the river was narrower and the banks were more stable. Where the river became too great (more than 170 feet wide), wet dredging was employed.

The Grand Calumet River remediation has components that are comparable to the Ashland site that should be considered when evaluating precedent:

- The dry excavation took place in a sheltered portion of the river, and not in an area with a large fetch, as at Ashland.
- Fewer problems with air emissions were encountered using a wet dredge versus a dry dredge at this site, as should be considered at the Ashland site.
- Wet dredging was allowed on this site except where the river was not wide (less than 170 feet) since dry dredging became too difficult when the width increased. At the Ashland site, the planned dry dredge is 200 feet wide, even more difficult to implement.

**What is the lesson/point:** This site points out some of the problems that anticipated for the Ashland site. The Grand Calumet project showed the difficulty associated with a 200-foot-wide dry excavation in a complex, contaminated environment. Because Lake Superior is a much less quiescent body of water than the Grand Calumet River, it is likely that maintaining a large dry excavation would be more difficult at Ashland.

Also, at the Grand Calumet River site, the dredged materials contained high concentrations of PAHs, similar to the Ashland site where high concentrations of benzene are expected. At the Grand Calumet River site, the air emissions resulting from dredging were more problematic during dry dredging than during wet dredging. This underscores the exposure and nuisance issues that are created by any dry excavation approach at the Ashland site.

## PG&E Shell Pond

**Setting/Description:** This was an environmental remediation project that was conducted under the direction of the California DTSC. Cleanup of the Shell Pond by Pacific Gas and Electric (PG&E) was first attempted in 2011. The project involved dredging and disposing of over 240,000 tons of petroleum-contaminated sludge from a wastewater pond in a populated area. The clean-up involved hydraulic dredging of sludge from the lagoon and discharging the slurry of dredged material into geotubes. The cleanup was shut down after four days of operation because air emissions from the remediation area were severe. The cleanup is currently being re-designed to better address air emissions.

This project is similar to the Ashland project because it involved a large volume of sediment that contained volatile constituents and the work took place in a populated area. It differs from the Ashland site in several key respects:

- The COCs at this site were predominantly diesel range organics (DRO), instead of naphthalene and benzene, as is the case at Ashland.
- The area dredged was not deep, nor was it subjected to wave forces such as those at Ashland harbor.
- Hydraulic dredging was used to remove the sediment.

**What is the lesson/point:** This site points out the importance of managing vapor emissions and odors at sediment sites. Even though the remediation area was much simpler than Ashland, air emissions from remediation derailed the sediment remediation, resulting in an actual shutdown of the project.

# D–EXAMPLE ENVIRONMENTAL DREDGING PROJECTS FROM SEDIMENT MANAGEMENT WORKING GROUP

| Project Name/ Location | Objective | Construction Technique/ Type of Containment | Type of Water Body | Max Fetch | Reference |
|---|---|---|---|---|---|
| St. Louis River/Interlake/ Duluth Tar, Duluth, MN* | Remove PAHs, tar, mercury, and heavy metals (non-mercury) | Dredging done with hydraulic dredge in the wet, capping, and confined aquatic disposal facility | Stryker Embayment of St. Louis River | Hundreds of feet over embayment | 0531, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Inland Steel, Indiana Harbor Canal, East Chicago, IN* | Remove PAHs, PCBs, metals, and taconite (ore) from canal, navigational dredging | Wet dredging | Indiana Harbor Canal | Tens of feet over canal | 0508, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Grand Calumet River, Gary, IN* | Remove PAH's, PCBs (primarily 1254), and metals | Hydraulic dredging, cofferdams , flow diversion, and sheet pile installation for bank stabilization | Grand Calumet River (east branch and small segment of west branch), Indiana Harbor Canal | Hundreds of feet along a 5-mile stretch of the Grand Calumet River | 0507, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Hog Island Inlet/Newton Creek/ Superior, WI | Remove petroleum hydrocarbons | Creek diversion; sheet off shallow portion of bay and dry excavation | Shallow embayment near Lake Superior | Hundreds of feet | http://www.epa.gov/glla/hogisland/index.html |

Site with an * include a CDF as part of the project

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| Housatonic River/Pittsfield, MA* | Remove PCBs and other NAPLS | River diversion, sheet pile, dry excavation | Housatonic River | Hundreds of feet over river | http://www.epa.gov/region1/ge/index.html |
| Tennessee Products – Project 1 (Hot Spot), Chattanooga, TN | Remove PAHs | Dry excavation, Port-A-Dams, flume tubes, bypassing creek flow, rock dams | Chattanooga Creek | Hundreds of feet over 2.5 miles of creek | 0406, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Ottawa River, Toledo, OH | Remove PCPs from river | Dry excavation, sheet piling, earthen berms | Unnamed Tributary to Ottawa River | Tens to hundreds of feet across 975 feet long tributary | 0519 & 0521, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Cannelton Industries, Sault Sainte Marie, MI | Remove metals (Cd, Pb, As, Cr, Hg) | Dry excavation, sheet pile wall | Tannery Bay, St. Mary's River | Hundreds of feet along 0.8 mile near shore area of river | 0503, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Fields Brook, Ashtabula, OH* | Remove PCBs (primarily 1248), metals, VOCs, SVOCs, radionuclides, DNAPL | Dry excavation, damming and by-passing creek flow | Fields Brook, Ashtabula River | Hundreds of feet along 3.5 miles of brook that is 25 to 400 feet wide | 0504, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Ruck Pond (Cedar Creek), Cedarburg, WI | Remove PCBs | Dry excavation, temporary dam, and flow bypass | Impoundment on Cedar Creek – tributary of Milwaukee River | Tens to hundreds of feet across 800 to 1,000 feet long by 75 to 100 feet wide impoundment in Cedar Creek | 0513, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Shiawassee River, Howell, MI | Remove PCBs | Dry excavation using PortaDam™ structures to divert water flow | South Branch Shiawassee River | Hundreds of feet across 8 miles of Shiawassee River | 0515, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |

Site with an * include a CDF as part of the project

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| Willow Run Creek, Ypsilanti and van Buren Townships, MI* | Remove PCBs (1242/1248/1254 /1260) | In-situ solidification followed by dry excavation | Willow Run Creek, Edison and Tyler Ponds, and Belleville Lake | Tens of feet across Edison and Tyler Ponds and Willow Run Sludge Lagoon | 0516, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Crotty Street Channel, Bay City, MI | Remove PCBs | Sheet pile wall, dewatering, and in-situ stabilization | Crotty Street Channel and Saginaw River | Hundreds of feet across Crotty Street Channel and Saginaw River | 0532, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Manitowoc River Basin, Clinton, WI | Remove PCBs | Dry excavation | Jordan Creek, Pine Creek, and Hayton Mill Pond | Hundreds of feet across 7 miles of creek and 30 acres of pond | 0534, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Sauget Area 1 (Dead Creek), Sauget and Cahokia, IL* | Remove PCBs, VOCs, and metals | Dry excavation, by-passing creek flow | Dead Creek | Hundreds of feet over 2.6 miles of creek | 0535, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Moss-American (Kerr-McGee Oil Co.) , Milwaukee, WI* | Remove PAHs | Re-route of river and dry excavation | Little Menomonee River | Hundreds of feet over 6 miles of river | 0542, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |

Site with an * include a CDF as part of the project

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| Ten-Mile/Lange/ Revere Canal (St. Clair Shores) | Remove PCBs, heavy metals, VOCs, and SVOCs | Sheet pile "seawall" and dry excavation; wet excavation with barge mounted excavator | Ten-Mile/Lange/ Revere Canal and Wahby Park Pond | Hundreds of feet over 4,400 feet of canal and pond | 0544, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Housatonic River – Project 1 (Hot Spot), Pittsfield, MA* | Remove PCBs (1254/1260) | Dry excavation from within sheet pile cells | Upper Housatonic River | Hundreds of feet over 550 ft. of river | 0101, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Loring Air Force Base, Limestone, ME* | Remove PCBs (primarily 1260), total PAHs, DDT, chlordane, lead | Dry and wet excavation | Flightline Drainage Ditch, Flightline Drainage Ditch Wetland, and East Branch Greenlaw Brook, | Tens to hundreds of feet over 20- 25 ft. wide by 2,500 ft. long ditch, 400 ft. wide by 2,000 ft. long wetland, and over narrow 2,500 ft. long stream | 0106, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| New Bedford Harbor – Project 2 (Harbor/Upper Bay), New Bedford, MA | Remove PCBs (1016/1242/1254) and metals | Dry excavation; hydraulic/mechanical dredge system | New Bedford Harbor (Upper, Lower, and Outer Harbor) and Buzzard's Bay | Hundreds of feet over 1000-acre tidal estuary/harbor/bay and over 50 acres of marshland | 0108, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Housatonic River – Project 2 (First Half Mile), Pittsfield, MA* | Remove PCBs (1254/1260) | Dry excavation within dewatered sheet pile cells | Housatonic River | Hundreds of miles over East Branch of the Housatonic River | 0109, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |

Site with an * include a CDF as part of the project

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| Housatonic River – Project 3 (Next 1.5 Miles), Pittsfield, MA* | Remove PCBs (1254/1260) | Dry excavation with river diversion by sheet piles and pumping bypass | Housatonic River | Hundreds of miles over 1.5 miles of river | 0111, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Former Messer Street MGP, Laconia, NH | Remove PAHs | Dry and wet excavation, mechanical dredging | Winnipesauke e River | Hundreds of feet over river | 0112, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Cumberland Bay, Plattsburgh, NY | Remove PCBs (1242), phthalates, PAHs, PCDDs, and PCDFs | Sheet piling, silt curtains, hydraulic dredging, dewatering, dry excavation | Cumberland Bay and Lake Champlain | Hundreds of feet over 57 acres in bay and lake | 0203, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| GM Central Foundry (Massena), Massena, NY* | Remove PCBs (1242 and 1248) | Barge-mounted backhoe, horizontal auger dredge, sheet pile, silt curtains, dry excavation, PortaDam system | St. Lawrence River, Raquette River, and Turtle Creek | Hundreds of feet over 2,500 ft. of river | 0204, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Gill Creek (DuPont), Niagara Falls, NY | Remove VOCs, mercury, and PCBs | Dry excavation | Gill Creek | Hundreds of feet over 250 feet of creek | 0205, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Hooker (102$^{nd}$ Street), Niagara Falls, NY* | Remove VOCs and heavy metals (including mercury) | Dry excavation | Embayment in Niagara River | Hundreds of feet over 25-acre embayment | 0206, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |

Site with an * include a CDF as part of the project

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| Lipari Landfill, Mantua Township, NJ | Remove 63 organic contaminants (benzene, toluene, xylene, etc.) and 13 inorganic contaminants (arsenic, chromium, lead, etc.) | Wet and dry excavation | Alcyon Lake, Chestnut Branch stream and marsh, and Rabbit Run (small tributary of Chestnut Branch) | Tens to hundreds of feet over 18 acres of lake, 5 acres of marsh, and 4 to 10 ft. wide stream | 0208, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Marathon Battery, Cold Spring, NY | Remove metals (primarily Cd, Ni, and Co) | Dry excavation, hydraulic and mechanical dredging, silt curtain, water-filled containment structures, and earthen berm | East Foundry Cove, Marsh, and Pond; West Foundry Cove; Constitution Marsh; small cove near Cold Spring Pier in Lower Hudson River | Hundreds of feet over 340 acres of backwater marshes and 200 acres of cove | 0209, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Love Canal, Niagara Falls, NY | Remove dioxins (including 2, 3, 7,8 – TCDD) | Dry excavation | Black Creek, Bergholtz Creek, and Cayuga Creek | Hundreds of feet over creeks | 0213, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Queensbury NMPC Site, Queensbury, NY | Remove PCBs (1242) | Dry excavation | Upper Hudson River | Hundreds of feet over river | 0214, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |

Site with an * include a CDF as part of the project

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| Mallinckrodt Baker (formerly J.T. Baker), Phillipsburg, NJ* | Remove DDT, lead, mercury, and cadmium | Dry excavation | Delaware River | Hundreds of feet over river | 0215, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Gill Creek (Olin Industrial Welding Site), Niagara Falls, NY* | Remove mercury, hexachloro-cyclohexane (BHCs), and Remove PAHs | Dry excavation | Gill Creek and Niagara River | Hundreds of feet over river | 0217, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Bay Road Pond, Queensbury, NY | Remove PCBs | Dry excavation | Bay Road Pond (Eisenhart Pond) | Tens to hundreds of feet over pond | 0221, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Dzus Fastener (Lake Capri), West Islip and Long Island, NY | Remove cadmium, cyanide, and chromium | Dry excavation | Willetts Creek and Lake Capri | Tens to hundreds of feet over 5.5 acre lake and 1,500 feet of creek | 0222, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| CIBA-GEIGY, Queensbury, NY* | Remove heavy metals | Wet and dry excavation | Hudson River | Hundreds of feet over 3,800 ft. of river | 0224, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Natural Gas Compressor Station, Kosciusko, MS | Remove PCBs (1242) | Dry excavation | Little Conehoma Creek | Hundreds of feet over 2 miles of 15-25 ft. wide creek | 0401, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Town Branch, Russellville, KY | Remove PCBs (1248) | Dry excavation | Town Branch River | Hundreds of feet over 3.5 miles of river | 0403, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Triana/Tennessee River | Remove DDT | Permanent rechannelization and stream diversion, dry | Tributaries to the Tennessee River | Hundreds of feet over 11 miles of tributaries | 0405, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |

Site with an * include a CDF as part of the project

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|---|---|---|---|---|---|
| | | excavation | | | |
| Koppers (Charleston Plant), Charleston, SC | Remove PAHs, pentachlorophenol, trace amounts of dioxin, lead and arsenic | Dry excavation | Ashley River | Hundreds of feet over river | 0408, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| National Zinc, Bartlesville, OK | Remove heavy metals (Cd, Pb, Se, and Zn) | Dry excavation | North Tributary (unnamed) of Eliza Creek | Hundreds of feet over tributary | 0602, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Silver Bow Creek, Butte, MT* | Remove metals (arsenic, cadmium, copper, lead, mercury, and zinc) | Dry excavation | Silver Bow Creek and Clark Fork River | Hundreds of feet over 24 miles of silver bow creek | 0801, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Milltown Reservoir Update, Butte, MT | Remove metals and arsenic | Dry excavation and bypass channel | Milltown Reservoir | Hundreds of feet over reservoir | 0802, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |

Site with an * include a CDF as part of the project

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| Commencement Bay Proj 1 (Hylebos)* | Remove polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), semi-volatile organic compounds (SVOCs), volatile organic compounds (VOCs), arsenic, copper, lead, mercury, and zinc | Dry excavation and hydraulic dredging | Hylebos Waterway | Hundreds of feet over 2.5 miles of waterway | 1001, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Commencement Bay Proj 4 (Middle Waterway)* | Remove copper, mercury, and polycyclic aromatic hydrocarbons | Dry excavation and dredging | Commenceme nt Bay | Hundreds of feet over bay | 1011, Major Contaminated Sediment Sites Database; Sept. 2004 as updated 2008. |
| Ford Outfall, River Raisin, Monroe, MI | Remove PCB contaminated sediments to hardpan in center of the river and PCB>10 ppm along the shoreline | Wet dredge using mechanical equipment | River Raisin in the location of outfalls from the Ford Plant | Hundreds of feet | 0505, Major Contaminated Sediment Sites Database; last updated in 01/2002 |

Site with an * include a CDF as part of the project

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# ATTACHMENT 2-D

ANCHOR QEA

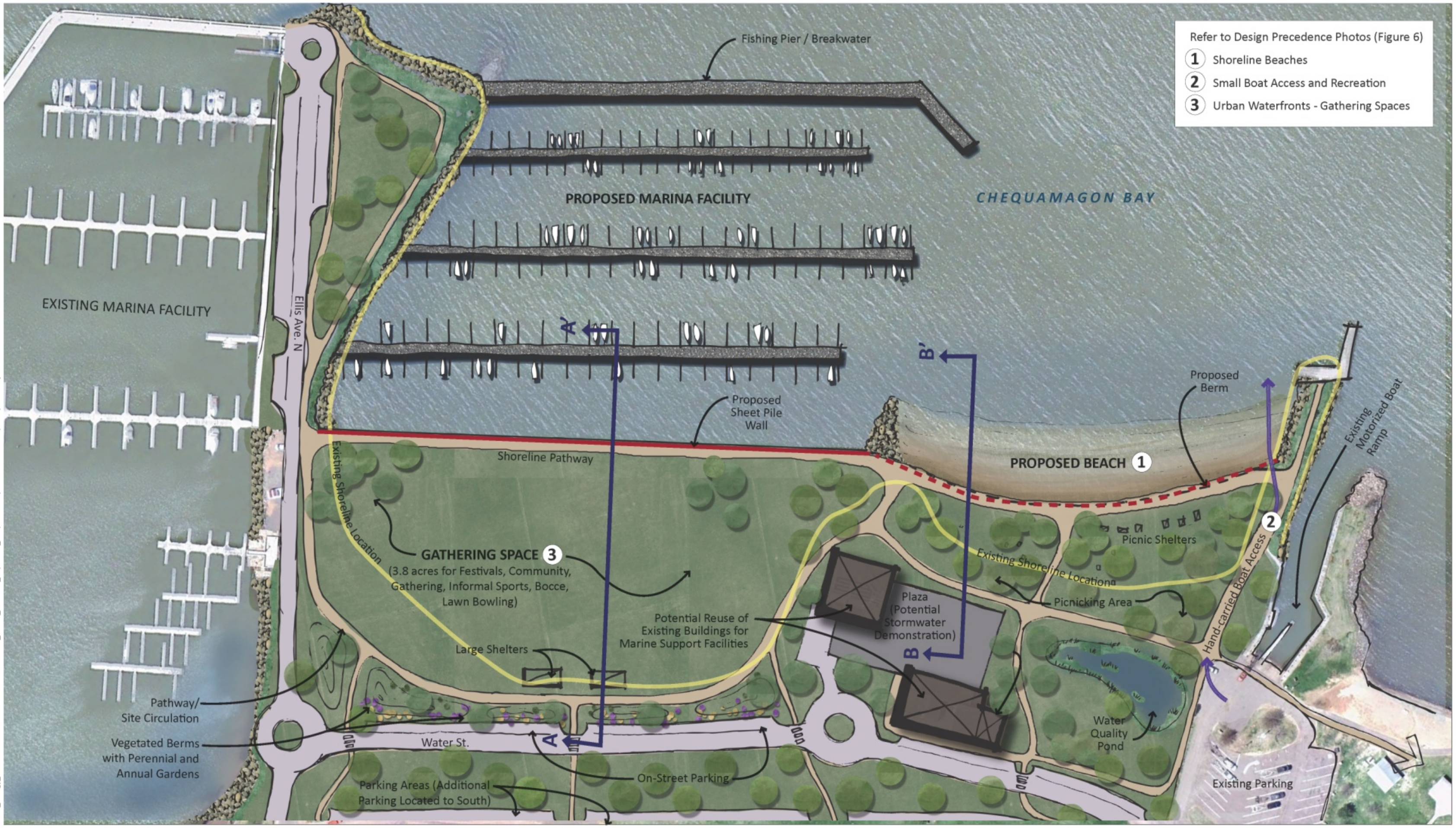



Figure 1
**Lakefront Park Option A - Marina with Breakwater**
Former Wastewater Treatment Plant, Ashland, WI

ANCHOR QEA

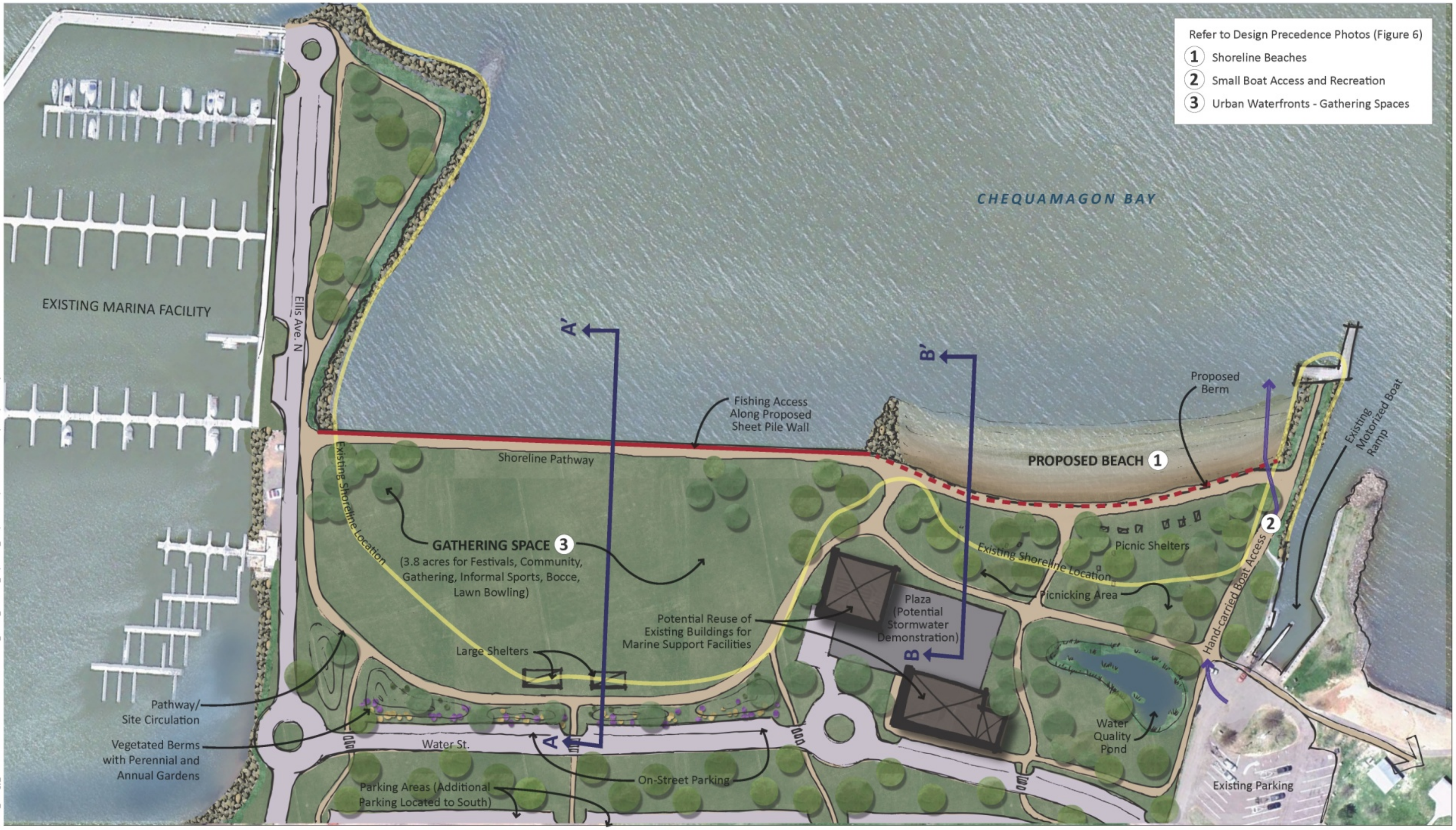
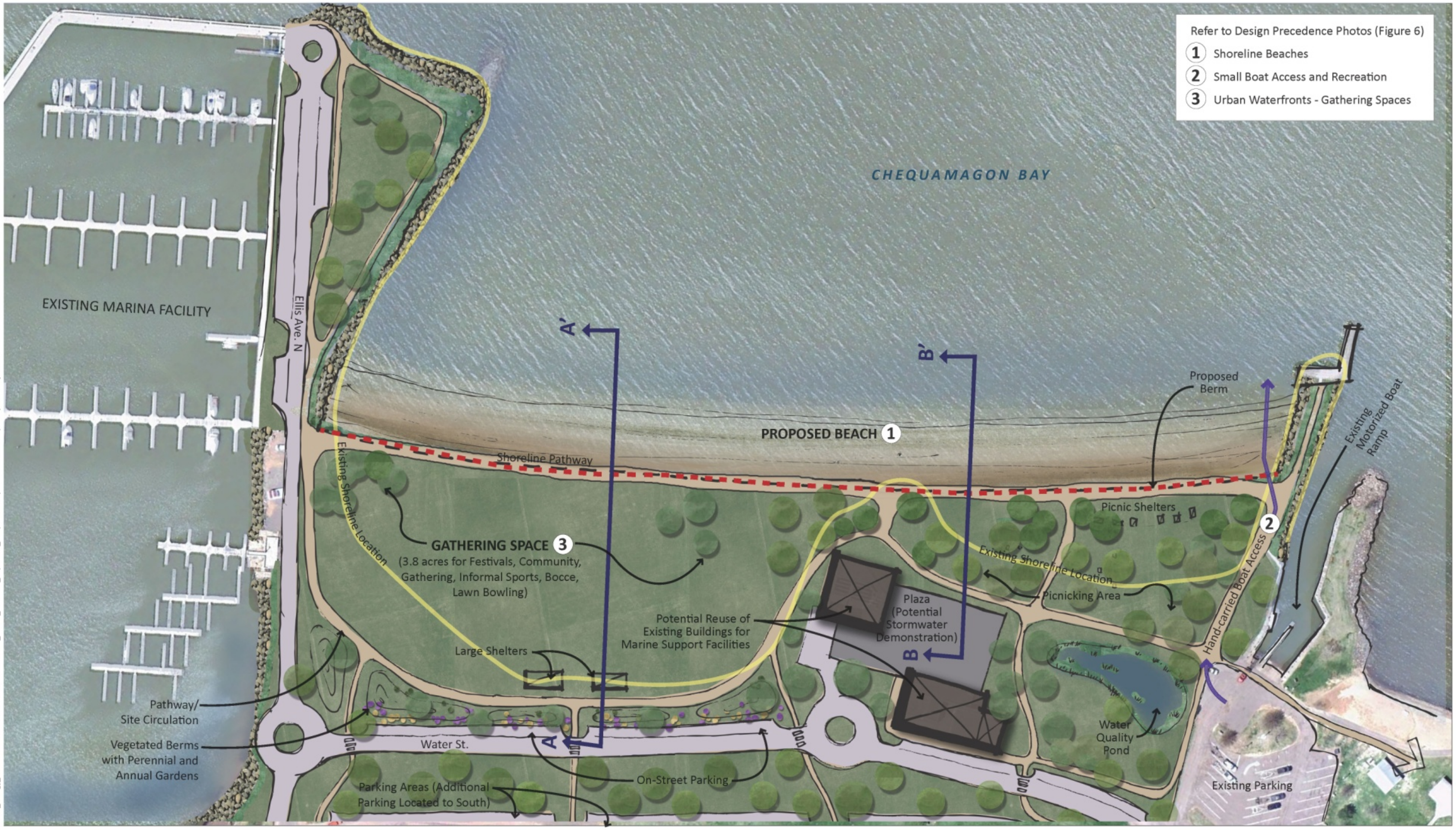



**Figure 2**

**Lakefront Park Option B - No Breakwater**

Former Wastewater Treatment Plant, Ashland, WI

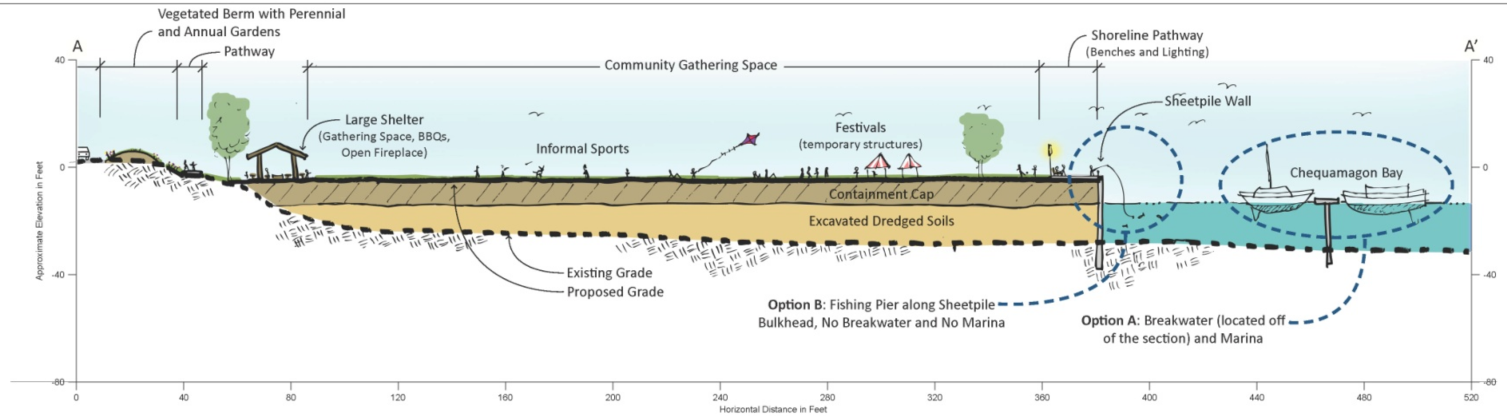



ANCHOR QEA

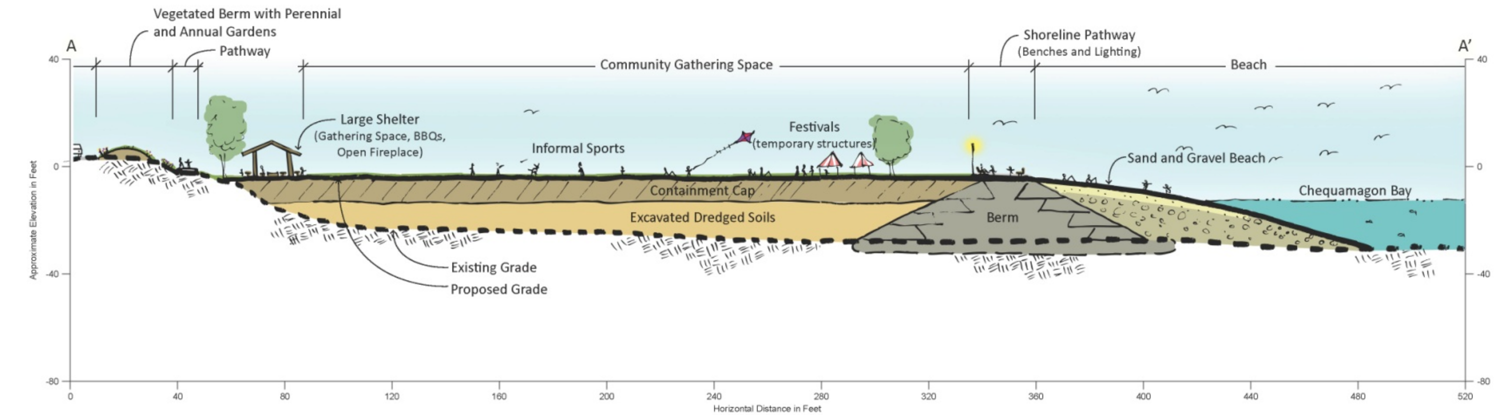
0 60 120
Scale in Feet

**Figure 3**
**Lakefront Park Option C - Beach**
Former Wastewater Treatment Plant, Ashland, WI

ANCHOR QEA




**SECTION A-A' (Options A & B)**

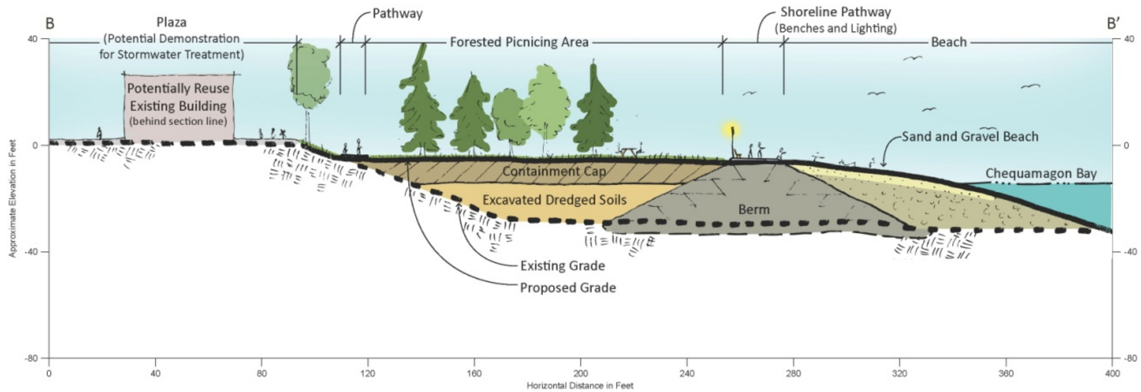



**SECTION A-A' (Option C)**

**VERTICAL DATUM**: Unknown.

0 20 40
Scale in Feet

**Figure 4**
**Conceptual Section A-A'**
Former Wastewater Treatment Plant, Ashland, WI




**SECTION B-B' (Options A, B, & C)**

**VERTICAL DATUM**: Unknown.





0 20 40
Scale in Feet

**Figure 5**
**Conceptual Section B-B'**
Former Wastewater Treatment Plant, Ashland, WI

## 1 Shoreline Beaches

Puget Sound, Seattle, Anchor QEA 2011

Lake Washington, Seattle, Anchor QEA 2010

Lake Washington, Seattle, Anchor QEA 2010

## 2 Small Boat Access and Recreation

Lake Washington, Seattle, Anchor QEA 2010

Lake Washington, Seattle, Anchor QEA 2010

Lake Washington, Seattle, Anchor QEA 2012

Lake Washington, Seattle, Anchor QEA 2012

## 3 Urban Waterfronts - Gathering Spaces

Malmo, Sweden, Google Images 2012

Portland, Oregon, Google Images 2012

Portland, Oregon, Google Images 2012



ANCHOR QEA

**Figure 6**
**Lakefront Park Design Precedence Photos**
Former Wastewater Treatment Plant, Ashland, WI

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